THE

ELECTRICAL REVIEW.

VOL. XXXIX. NOVEMBER 13, 1896. No. 990.

CONTENTS:

	PAGE
On Cheap Steam Power	615
The Durability of Telegraph Cables	617
More about the Heilmann Locomotive	617
Tests of 150-Kilowatt Parsons Turbo-Alternator (*illustrated*)	618
Speed Regulation of Induction Motors (*illustrated*)	618
The Electro-deposition of Zinc	619
The Application of Electricity in Breweries	620
Electrically Driven Ladder Dredger (*illustrated*)	621
Correspondence:—The Insurance of Central Stations	622
Re the Jandus Lamp.—Information Wanted	622
Electricity in Mines.—Made in America	623
Inductive Capacity	623
There is Neither Electricity nor Ozone in it	623
Croydon Electricity Works	624
International Submarine Memorial	624
Inductor Alternators	624
The Earl's Court to Mansion House Underground Electric Railway Scheme	624
The New Motor Cars Act	625
The International Submarine Telegraph Memorial	626
The Institution of Electrical Engineers (*illustrated*)	626
Legal	627
Business Notices, &c.	628
Electric Lighting Notes	630
Manchester Ship Canal Electricity Works (*illustrated*)	631
Bury Electricity Supply Works (*illustrated*)	633
Electric Traction and Motive Power Notes	636
Telegraph and Telephone Notes	637
Contracts Open and Closed	638
Notes	638
City Notes	641
Traffic Receipts	642
Share List of Electrical Companies	643
Triple or Compound Engines	644
A New Reducing Gear (*illustrated*)	645
Railway Speeds	646
What Electric Lighting Really Costs	646
Proceedings of Societies:—	
The Northern Society of Electrical Engineers	647
Physical Society	649
Some Notes on Superheating	649
New Patents	650
Abstracts of Published Specifications	650

THE
UNIVERSAL ELECTRICAL DIRECTORY
(J. A. BERLY'S).

PRICE 6/- POST FREE.
The Leading Electrical Trades Directory and the Oldest Electrical Directory in the World.

1896 ISSUE.

PRICE 6/- POST FREE.
Fully Revised and Thoroughly Reliable.
Contains a larger amount of Trade Matter than any other Electrical Directory.

H. ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address: "AGEKKAY, LONDON." Code A B C. Telephone No. 6,933.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trader.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To *all other countries*, per Year, £1 4s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 6s. or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 22, Paternoster Row, E.C.

ON CHEAP STEAM POWER.

MR. J. S. RAWORTH read a paper on "Cheap Steam Power" before the Northern Society of Electrical Engineers, at Manchester, on November 10th, a part of which is reproduced in this issue. His object was to show to what extent it would pay to use expensive engines to secure commercial, as distinct from mere *primâ facie* economy. He considers that in the aggregate small engines exceed large engines in power, yet the large engines have been made the object of skill and ingenuity, and have thereby attained a high degree of excellence, while small engines have, until the advent of electricity, been neither understood nor cared for. Six items are taken to make up the cost of steam power, viz.—coal, labour, maintenance, interest, depreciation, and cost of breakdown, a seventh item, that of water, being omitted by the author as of small account, either for reasons best known to himself, or because he was speaking to a Lancashire audience, in whose locality water is often more available than in London, where it is a denser and more serious item.

The relative importance of the different items obviously depends upon the load factor or ratio of working hours to total time. For a cotton factory this factor is 27·7 per cent., and for an electric engine at 500 hours per annum at full load it is only 5·7 per cent. In these two cases the cost of a 1,000-H.P. engine per H.P. hour will be 0·27 and 1·44 pence. The capital costs in these instances are respectively £10,000 and £16,000. In the second example, which is supposed to consume twice the coal per H.P. hour as the first example, the horse-power hour costs a total of six times what it does in the first case, while the item of capital charge is 7½-fold. In the cotton mill, coal comes first at ·105 of a penny; in the electrical station it is only 14·7 per cent. of the total cost; but its actual cost is, nevertheless, ·215d. per H.P., so that we can hardly agree that it is not a serious item, even at first sight. As a fact, a greater coal consumption implies an increase in boilers, pumps, &c., and only saves in securing a cheaper engine. Seeing that capital charges, however, amount to one half the total cost, it is obvious that not much benefit is to be derived from a coal economy procured by means of greater capital outlay. In most cases triple-expansion engines would not balance the accompanying disadvantages, especially as greater complication implies greater risk of breakdown. If the steam consumption of different classes of engines be taken at from 12½ to 18½ lbs., the real consumption will be somewhat different, for there is likely to be a less mechanical efficiency in the more complicated machines.

Nothing, it is considered, has ever touched the Corliss engine for all round satisfactory economy. The idea is scouted that this satisfaction arises from the nicely shaped diagram, for engines with no diagrams at all, so to speak, will run the Corliss engine very close, and even the throttling engine will beat it at light loads. Corliss economy all arises from small clearance and good drainage, and we are disposed to accord this statement every credence. The more modern views of

steam engineering would have endorsed the Corliss engine on its drainage system if invented to-day. Of its clearance we cannot speak so highly. The author considers that piston valve engines have the worst clearance volumes. We think he exaggerates this point. Corliss valves, especially when long and on the barrel of a cylinder, have far from moderate clearance volumes. When placed in the ends of the cylinder, their clearances may be very small, but when so placed they are not so efficient as drains. We do not think that due credit is given to piston valves. Properly designed, they afford very short passages, and fairly small clearance spaces. We are quite at one with the author in his general condemnation of the vertical engine as being usually so very poorly drained, and this remark applies not only to piston and slide valve engines, but to Corliss engines likewise, and so long as engines work wet this must always militate against the vertical type of engine until someone suitably dishes the piston in a similar manner to the piston of the Willans engine, and drains the top end of the cylinder through the piston rod.

Considering, then, all the advantages in favour of the Corliss horizontal engine, can it be improved upon? Thus skilfully we are carried on to the author's own pet universal engine. The author first premises that at electric light stations, working under peculiar conditions, very uneconomical engines, if cheap and small, will probably be more economical on the whole than the highest class of Corliss engine, and if this be so there is doubtless good reason to suppose that a small engine, if cheap and also well designed, will be sufficiently economical to pay for a certain advance in cost above the badly designed engine. Such an engine exists in the Universal Engine of the author himself. It is claimed that taking the Corliss engine as a basis for comparison (*a*), the clearance can easily be reduced for a given length of stroke; (*b*) the initial exposed surface can be reduced; (*c*) the cylinder drainage is better; (*d*) the valves are more favourably placed. With these improvements the Universal engine has been tested to show a steam consumption of only 19·3 lbs. per I.H.P. hour on an engine of 14½ inches diameter L.P. cylinder by 6 inch stroke when developing 45 H.P. with steam at 140 lbs. pressure. The consumption, therefore, only exceeds by 16 per cent. the conditional theoretical consumption of 16¼ lbs. Having thus favourably introduced his engine, the author proceeded to show that it was cheap to buy. As compared with an ordinary Corliss compound, the application of the Universal type of cylinders would reduce the number of valves to four instead of eight. The H.P. cylinder and piston take the place of, and cost no more than a tail rod and guide, and the cost of the L.P. cylinder, lagging, and cocks, is all reduced. The same remarks apply even more forcibly if triple expansion engines be compared, for in place of four cylinders with 16 valves in the Corliss engine, there are only two valve boxes and four valves in the Universal engine.

Taking the first two examples of a cotton mill and an electric station, our author now advances figures to show that in place of a capital expenditure of £10,000 and £16,000, and a coal consumption of 2 lbs. and 4 lbs., the use of the Universal engine would require expenditures of £7,000 and £10,000, and the coal consumed would be 1¾ lb. and 3 lbs., while the cost per H.P. hour from being 0·254 and 1·44, would become 0·2d. and 0·9d., showing savings of 20 and 37½ per cent. respectively in a commercial sense on a large scale. Reverting, however, to the more numerous class of small engines, the case is assumed of a 40 H.P. engine costing ordinarily £400, and using 7 lbs. of coal per H.P. With a load of 25 H.P. and a load factor of 19·2 per cent., or 70,200 H.P. hours annually, the common engine will cost 0·84 per H.P. hour, while a Universal engine costing £360 would only burn 3 lbs. of coal, and show a cost of 0·58 lbs. per H.P. hour, or a saving of nearly £77 per annum. The saving in prime cost is supposed to be made altogether in the boiler, and in a small engine there is a considerable saving in fuel and something in maintenance. We are compelled to admire the presentation of his own engine before the Society, and no doubt Mr. Raworth feels perfectly satisfied in his various comparisons, though it is difficult either to refute or approve mere approximations and suppositions, as such must always be. There can be no doubt, however, that there is a wide field for Mr. Raworth's engine. Its design is extremely neat and ingenious, the valve arrangement is good, the steam distribution is well arranged, and peculiar facilities are afforded in a simple manner for freeing the cylinders of water, at the same time the engine is not one that any ordinary workshop need hesitate to take in for overhauling or repairing.

So long as the load factor in an electric station is so very small, the first cost of plant must always be a very serious item. This item shows no tendency to decrease in importance. The visionary day load remains as visionary as heretofore, and the present state of electric lighting, so far at least as the production of current is concerned, cannot be described as having reached any degree of finality. The electric lamp by which we now ought to be writing—if we may so plagiarise Michael Scott—receives its energy every moment from an engine several miles away, which could not stop for a second without extinguishing the lamp. Should these things be, and does such a method of working appear fit or proper to engineers generally? Until some better system of manufacture can be introduced which will do for electricity what the holder does for gas, the cost of power must always be a serious item, and every means tending to reduce it must be afforded consideration.

The Prospective Boom in Traction.

It is difficult to say whether electric traction will ever be boomed to the same extent as horseless carriages and bicycles. The chances are, however, that the absence of opportunities for making deals will preclude anything in the nature of an acute boom. As a matter of fact the interests of the electrical industry will be better served if the speculative elements are kept under. We do not desire to see quintuple millionaires made out of electric traction, we want steady and safe progress made during the next few years. If the investing public, which by the way has a fondness for electric tramway stocks when they happen to be American, will pay some attention to the movement in favour of electric traction in this country, they are bound to discover some paying investments. The prospectus of the British Electric Traction Company, which is referred to in our "City Notes," is important as showing that our progress in traction is real. The moderation of the company's estimates make one sanguine as to its prospects, and, as the success of this company will mean much to the electrical industry, we trust a full measure of prosperity will attend its career.

THE DURABILITY OF TELEGRAPH CABLES.

On this subject there has been, at various times, considerable conflict of opinion. Those whose interests are opposed to the laying of a cable across the Pacific, have warned us against the insuperable difficulties to be met with at the various landing places in that ocean; as, however, the same individuals have also urged that the proposed cable route is unsurveyed, it is difficult to know on what grounds such a warning is founded. We are inclined, therefore, to look on these interested statements as of extremely little value. No such objections were raised by the proprietors of the system of cables which so strongly opposes the Pacific scheme, when they undertook to lay, for the consideration of a Government subsidy, the cables which unite Zanzibar with Mahé in the Seychelles, and with Mauritius. These cables were laid some years ago, and we have not yet heard of their interruption. A description of these places from unprejudiced parties will be of interest in this connection.

From a paper read last year before the Geological Society by Major de Haga Haig, R.E., and already referred to in this journal, on the "Physical Features and Geology of Mauritius," we make the following extracts:—

"The gentle slopes on each side are stopped, round the greater part of the circumference, by ranges of mountains up to nearly 3,000 feet in height, so thin and steep as to resemble walls. From the outer precipices of these, comparatively level plains of variable width stretch to the sea. The northern part of the island—the pointed end of the pear—is cut off from the rest by these mountain walls, but the general direction of the watershed continues across it at a much lower level, and is even prolonged under water by a bank extending 14 or 15 miles before it sinks to 100 fathoms below the sea: the general depth of the sea-bottom around being about 1,800 fathoms. The five or six small islands to the north are on this bank, which also rises in some places in the objectionable form of dangerous reefs, on which a furious surf is always breaking. There is also a bank called 'l'Ilot aux Pintades,' extending from the south-western point of Mauritius (10 miles) towards Bourbon, which appears to be a continuation of the central ridge. In fact, Mauritius is on a line of weakness of the earth's surface, along which volcanic disturbances have taken place. This line passes through the volcanic islands of Rodriquez, Bourbon, and Madagascar. From soundings taken round Mauritius and Bourbon, in connection with a scheme for laying a submarine telegraph cable, it was found that between the two there was a level sandy plain at a depth of 1,800 fathoms, which extended all round Mauritius, except to the north, where, as one of the men employed on the work stated, 'it was like sounding over precipices; depths of 600 and 1,300 fathoms would often occur in close consecutive soundings.' The neighbouring island of Bourbon still contains an active volcano, whose eruptions are of frequent occurrence, and it seems probable that both islands are on the same line of action of the subterranean force which has thrown them up. So we may regard this active crater as the safety-valve which prevents the doubtless diminished subterranean heat from venting itself on Mauritius. Were the Bourbon volcano to become choked from any cause, there might be danger to the sister isle. It is evident that the volcanic fires beneath Mauritius are merely dormant, not extinct, for they have several times manifested themselves by earthquakes, for example on May 15th, 1854, August 24th, 1860, and January 6th, 1863."

In the abstract of a paper read last June before the Berlin Geographical Society by Dr. A. Brauer, we find the following descriptive of the Seychelles:—

"The Seychelles, strictly so called, rise from a submarine bank covered by 10 to 40 fathoms of water, the depth increasing suddenly towards the Amirante islands to between 1,500 and 2,000 fathoms. In contrast to Mauritius and Réunion, which are of volcanic origin, and to the Chagos Archipeligo further north, as well as the Amirante, Aldabra, and other small groups to the southward between the Seychelles and Madagascar, which are of coralline formation, the Seychelles are wholly composed of granite, and they derive from this certain distinctive characters. In the other parts of Mahé and on the other islands the mountains are lower, and are faced by wide coast plains of coral sand. The coast being steep, and fringed in most places by a coral reef, the islands are on the whole rather inaccessible; the smaller islands can only be reached by small vessels, and even these are often exposed to considerable danger. The Coral reefs are in general of the usual formation: round the living reef, which goes steeply down to from 10 to 12 fathoms, extends a plateau of varying width, consisting of detritus broken off by the surf. Nearer shore the bottom consists of coral sand, and close in the sand is deposited in dunes. Between the live reef and the land is a wide uniform channel. One would naturally classify the Seychelles reef as a barrier reef, but it must not therefore be supposed that it was formed, like many barrier reefs, by a displacement of the coast; for, notwithstanding the common belief that the Seychelles have for long been and are still undergoing depression, raised coral reefs can be found on almost all the islands, and there is abundant evidence that elevation is still going on. It is true that actual uplifting can only be proved definitely for a height of 80 feet, but, from the positions of many of the granite masses, it seems probable that the amount is much greater. On the Aldabras also coral-rag was found at a height of 50 feet."

From the above descriptions it would seem not improbable that to the Zanzibar, Seychelles, Mauritius cable may (in due course of time) be applied the words used by the late Sir John Pender, chairman of the Direct United States Cable Company, who in January last spoke as follows:—

"We have just repaired our cable on this side, which has been hanging on a rock for 22 years. Notwithstanding this, it had continued to work without interruption until December last."

MORE ABOUT THE HEILMANN LOCOMOTIVE.

This complicated machine continues to receive considerable attention all round, perhaps more by reason of its complications than its merits. One is constrained to award a certain amount of praise to this engine, if only by reason of the boldness of the undertaking. A certain mede of success, too, seems so far to attend upon the idea, if it be true that a company has been formed in Russia to pay half a million sterling for the patent rights, and that it has been already arranged to build several of a power of 2,000 H.P. for the Russian railways. If, however, as now reported, the idea of Heilmann is to abolish the reciprocating type of engine altogether, and replace it by the steam turbine, it would appear as though Heilmann had become, what Americans term, a crank on the question of reciprocation. One of his ideas in desiguing this locomotive has been to diminish the want of balance that arises in the ordinary engine, and he has gone to the rather great extreme of the Willans six-crank engine in carrying out his idea. Now even that is not good enough, and the steam turbine, with its perfect rotary balance is to be introduced. Already the numerous transformations bid fair to rob the Heilmann engine of any economy that it might possibly secure by reason of any supposed superiority in its steam power over the economy of the ordinary locomotive engine. We have always looked on this fancied economy as one rather of supposition than fact, for we have no mean opinion of the economy of the locomotive as at present constructed, and cannot see that any great result can arise from a change in the steam machinery, such as that involved in the multi-cylinder arrangement necessary with a six-crank Willans engine. Though we think this is carrying things further than necessary to secure a reasonable and sufficient balance, the idea of using steam turbines is, we fear, not called for at all on the score of balance. Whether the steam turbine will prove an economy is problematical. The steam turbine is not necessarily a wasteful engine; its principles are good; it only awaits improvement in design to become a really economical machine: there is little or no cylinder condensation in the steam turbine.

But, so far as at present known, the steam turbine is not suited for work except as a condensing engine. We would not hint that to make the Heilmann engine into a condensing machine would be any strain upon the genius of its inventor; are there not water troughs to be placed between the rails, and cannot it be arranged to pick up condensiog water by a

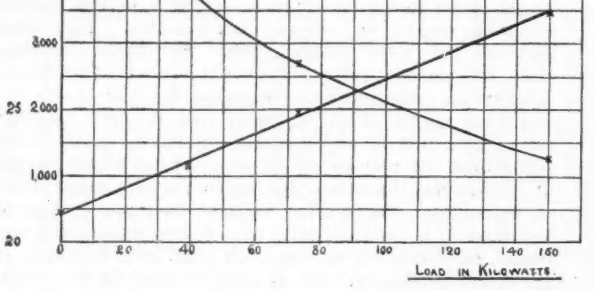
scoop? Surely so simple a means ought not to be neglected to make the turbine possible. The use of the Heilmann locomotive is rather like swapping horses while crossing the stream. Perhaps in the process of evolution we may yet see the steam turbine placed in a station on *terra firma*, and current led to the locomotive by a wire and a trolley. The Heilmann engine is evidently a great educational factor. It would be well if it were watched for further movement, for clearly it is moving in one direction, if not in others. Where this last move will lead it will be interesting to note, but, perhaps, unsafe to prophesy; but, on the ground that simplicity in a locomotive is usually preferable to an extreme economy of fuel, if this latter is only to be secured by complication of parts, we would by no means condemn the use of the simpler turbine in place of many cylinders, and we confess to feeling at least an interest in this novel use of the steam turbine.

TESTS OF 150-KILOWATT PARSONS TURBO-ALTERNATOR.

The following steam tests made by Mr. William D. Hunter, M.I.E.E., the engineer to the Newcastle and District Electric Lighting Company on a 150 kilowatt alternator supplied to them by Messrs. C. A. Parsons & Co., show what extreme economy of steam may be obtained with the compound steam turbine under ordinary conditions.

The plant consisted of a compound steam turbine of Messrs. C. A. Parsons & Co.'s latest improved type, geared in the ratio of two to one by helical spur gearing, to one of their standard type 150-kilowatt alternators and direct coupled exciters, the speed of the motor being 9,400 revolutions per minute, and that of the alternator and exciter 4,700 revolutions per minute.

It will be noted that the pressure at the steam chest of the motor was only 70 lbs. per square inch, and the vacuum only 26⅛-inch to 26¾-inch, so that neither pressure or vacuum were exceptionally favourable to economy, the object of the test made, however, was to ascertain the economy under ordinary working conditions.



The consumption of steam was measured by carefully calibrated tanks from which the feed was drawn, and the electrical output was taken by a "Kelvin" wattmeter, cross-checked by independent amperemeter and voltmeter, no steam separator was used nor was the steam superheated. The power was absorbed by a water resistance.

It is scarcely necessary to draw special attention to the importance of the results which follow, especially when it is remembered to what an extent the light loading of plant affects the economical working of a generating station.

Reference to the diagram shows the total water used per hour for about full, half, and quarter load to be respectively 3,484, 1,950, and 1,150 lbs., or expressed as lbs. per electrical horse-power per hour, the figures become 17·28, 20 and 22·01 respectively. It will be seen that points taken in the diagram connecting water and power fall sensibly in a straight line, and the uniformity is such that the approximate water consumption for any intermediate power may be readily taken off.

It is further to be noted that the quantity of water used when the generator was running at full voltage, but without doing work, was exceedingly small, and since the diagram shows that from this point the consumption of water increases with the load at approximately constant ratio, the importance of being able to keep the "no load" consumption down is at once apparent.

The generator worked throughout the trials in a most satisfactory manner, the design of the gearing and workmanship, together with the automatic lubricating arrangements showing to advantage in the smooth running of the machine. The governing also was excellent.

Tests of 150 Kilowatt Geared "Turbo" Alternator, October 26th, 1896, for the Newcastle and District Electric Lighting Co., Ltd.

Units.	Vacuum at cylinder.	Total water per hour lbs.	Water per unit lbs. per hour.	Water per E.H.P. lbs. per hour.	Revs. per minute.	Remarks.
150·33	26⅛	3,484	23·17	17·28	4,700	Barometer 29·3 Pressure of steam at generator 70 lbs. per square inch.
72·84	26⅛	1,950	26·77	20·0	4,700	
38·97	26⅜	1,150	29·51	22·01	4,700	
·17	26¾	437	...	...	4,600	

SPEED REGULATION OF INDUCTION MOTORS.

The American *Electrician* for September contains an interesting article by Mr. P. M. Heldt, on the similarity in the methods of regulating the speed of ordinary direct current shunt motors and alternating current induction motors.

In a shunt motor the following expressions hold for the speed and torque respectively:—

$$\text{Speed} = \frac{k\,e}{N\,C} \qquad (1)$$

and

$$\text{torque} = k'\,N\,C\,i \qquad (2)$$

Where k, k' are constants for a given machine; e is the back E.M.F.; N is the total magnetic flux through the armature; C is the number of conductors on the armature; and i is the armature current.

These expressions show that the speed of a shunt motor may be changed by varying one or more of e, N, and C. The back E.M.F. may be varied by inserting a variable resistance in the main circuit, and so admitting of a variation of the applied potential difference between the motor terminals; this method would at the same time vary the magnetic flux through the armature, but not to the same extent, so that a diminution of the applied potential difference would cause a drop in the speed. A better and more usual way is to put the variable resistance in series with the armature, while the applied potential difference is kept constant.

The speed might also be changed by varying the position of the brushes, and so altering the number of effective armature conductors. This method is, however, of little use since sparking occurs when the brushes are moved from the neutral point.

Another possible method of varying the speed consists in winding the armature with two or more windings, each having its own commutator, which can be coupled in series or in parallel; to vary the speed continuously a resistance in series with the armature is also necessary. When not running at full load the speed may also be increased by placing a resistance in the field coils, or a magnetic shunt across the armature, since by so doing the total flux will be diminished.

In the case of an induction motor the magnetic field is not stationary but revolves (if the machine is of the best make) with a uniform angular velocity. The induced E.M.F. in the rotor is not proportional to its angular velocity but to its angular velocity *relative to the rotating field*—due to the

stator windings—that its induced E.M.F. is proportional to the *slip*. Furthermore, the slip is proportional to the impedance of the rotor coils so that we may write

$$\text{slip} = \frac{\text{K } i \text{ I}}{\text{N C}}$$

where I is the impedance of rotor windings and K a constant.

Now the product i I equals the E.M.F. induced in the motor so that

$$\text{slip} = \frac{\text{K } e}{\text{N C}} \qquad (3)$$

which is of the same form as equation (1).

In the columns of the ELECTRICAL REVIEW* it has been shown that

$$\text{torque} = \text{constant} \times \text{slip} \times \frac{\text{N}^2 \text{ R C}^2}{\text{I}^2}$$

where R is the resistance of the rotor coils, therefore

$$\text{torque} = \text{constant} \times \frac{\text{N C } i}{\text{I}}, \qquad (4)$$

which is similar to equation (2) with the exception that the impedance occurs in the denominator. If we assume that the slip does not vary appreciably as the load is altered, the impedance will be constant, and equation (4) becomes

$$\text{torque} = \text{constant} \times \text{N C } i \qquad (5)$$

which is the same as equation (2).

The same means, therefore, that are used to regulate shunt motors may be adopted for the regulation of induction motors. The latter has, however, an advantage over the former, since to diminish the applied potential difference between the terminals of a shunt motor, a resistance *only* is useful, whereas either a resistance or a variable choking coil may be employed with an induction motor, and—let us emphasise this point—a choking coil will reduce the applied potential difference the required amount with a less expenditure of energy than when a non-inductive resistance is used.

If the rotor is suitably wound, the speed may be reduced by placing resistance in series with the rotor coils, but this is of course impossible in the case of the squirrel cage type. A more efficient method is to connect the stator windings to a switch in such a way as to render the number of poles capable of variation. If there are nominally $2p$ poles, or p pairs of poles on the stator, we know that the number of complete revolutions per second made by the rotating magnetic field is $\frac{n}{p}$, where n is the frequency of the applied potential difference; if, then, the stator coils can be connected with a switch in such a way as to render p capable of variation, the speed of the rotating magnetic field, and, consequently, that of the rotor can be subjected to a number of variations dependent on the adaptability of the switch. Although diminishing the number of poles of the stator causes a proportional diminution in the angular velocity of the rotating field, it does not follow that the speed of the rotor will be diminished in the *same* ratio, since the slip may change.

The following table, taken from a paper by Dr. Behn Eschenberg in *Electrotechnische Zeitschrift*, gives some experimental data of a 3-horse power three-phase Oerlikon induction motor. The stator is wound with 12 coils which,

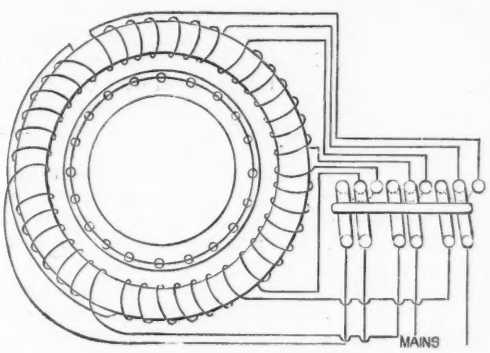
No. of poles.	Revs. per min.	Torque in lb. ft.	Efficiency in per cent.	Output in H.P.	Current in amperes.
2	1,700	0	...	...	9
2	2,650	5·78	77	3	13
2	0	10·12	...	...	90
4	1,350	0	...	...	9
4	1,320	11·56	75	3	13
4	0	23·12	...	...	60
8	675	0	...	...	9
8	640	20·24	70	2·5	13
8	0	70·12	...	...	35

by means of a regulating switch, can be so connected as to form eight, four, or two poles. No particular attention was paid to keeping the capacity and "no-load current" constant.

The table shows that by this switch arrangement the speed may be reduced to one-fourth the highest value without much sacrifice in output and efficiency.

In the adjoining figure, taken from the American *Electrician*, is shown diagrammatically a three-phase motor with a pole-changing switch. With the switch set as shown the motor has two poles; in the other position it has four poles.

It is probable that the method of regulating induction motors which will eventually prove the most practicable will be one depending on changing the frequency of the



supply current. Professor Rowland's frequency transformer gives us an idea to work upon, and electrical engineers will advance the progress of power transmission by alternating currents not a little when they place in the market a *frequency transformer* by means of which continuous variation of the frequency may be effected so as in this manner to regulate induction motors by change of frequency, when placed on to mains carrying current at constant frequency.

THE ELECTRO-DEPOSITION OF ZINC.

THE records of the Patent Office bear ample evidence that many experiments have been carried out at different times with the object of cheapening the process of coating iron with zinc, and of avoiding the deterioration of the quality of the material which usually follows pickling and hot galvanising.

Amongst these improvements are those based upon electrolytic methods. Most authorities recommend a current density of 15—20 amperes per square foot of cathode surface, at an E.M.F. of three volts at the terminals of the depositing bath, the solutions employed being zinc sulphate, acetate or chloride, ammonium chloride or tartrate. An improved electrolyte, invented by Herman, has been tried on a commercial scale, the chief feature being the addition of the sulphate of the alkalis or alkaline earths to a weak solution of zinc sulphate.

At a recent meeting of the London section of the Society of Chemical Industry, Mr. Sherard Cowper-Coles read an interesting paper on the electro-deposition of zinc; a paper which was illustrated by numerous diagrams, drawings and photographs, as well as by specimens of work which have been carried out. He said that he had obtained good bright deposits from a solution composed of 40 ounces of zinc sulphate (sp. gr. 1·1770 = 19 per cent. of crystallised zinc sulphate), and 5 ounces of ferrous sulphate to the gallon of water, the anodes being of lead. The iron salts should be brought to the ferric condition, as no deposit of iron can be obtained from a solution of a ferric salt. The generation of hydrogen at the cathode reduces the salt to the ferrous condition, which is again converted into the ferric by the corresponding oxygen liberated at the anode; the formation of zinc sponge is thus considerably reduced. Thin coatings of zinc obtained from acid solutions under favourable conditions are very adhesive when proper care is exercised in the preparation of the receiving surface.

When zinc is deposited of a thickness corresponding to more than 1½ ounces per superficial foot upon iron or steel; it does not form a continuous adherent coating. Attempts

* ELECTRICAL REVIEW, p. 141, January 31st, 1896.

have been made by the late Dr. Leeson and others to overcome this difficulty in the same way as the want of adhesion in silver-plating was overcome, namely, by quickening—that is, immersing the copper or copper alloy in aqueous solution of mercury; but in the case of iron the mercury has to be deposited electrolytically, as the iron will not amalgamate with the mercury. Under unfavourable conditions the zinc coating is of a transitory nature, its durability being incompatible with hot galvanising, as the deposit is porous, and retains some of the acid salts which cause a wasting of the zinc and rusting of the steel or iron.

One of the difficulties in depositing zinc is, that the layer is apt to be pierced with small holes, but Mr. Cowper-Coles stated that zinc could readily be deposited free from holes and ductile when the proper density and strength of solution are maintained; such zinc appears to have the properties of rolled, rather than cast zinc. He considers that the presence of free acid accelerates the formation of spongy zinc.

According to the Post Office test for telegraph wires, zinc electro-deposited upon iron and steel is found to resist the corroding action of a saturated solution of copper sulphate as well, if not better, than zinc, applied by the hot or dry method.

Mr. Cowper-Coles called attention to the slowness of ordinary electro-zincing, the trouble experienced in coating articles of an irregular shape, and the difficulties occasioned by the formation of loose, dark-coloured patches. These difficulties, and the unhealthy non-metallic look of the zinc coating obtained by the humid process, its want of brilliancy and glitter, has prevented ordinary electro-zinced articles finding favour with engineers and the trade for many purposes.

Troubles are also experienced from the scaling and furring up of the anodes, the electrolyte constantly getting out of order when working with a large current density, as more metal is taken out of the solution than can possibly be dissolved from the anodes, on account of the rapid formation of an insoluble scale on the surface of the anode. The scale is constantly peeling off, and has a tendency to settle on the cathode, spoil the zinc deposit, and forms a thick sludge at the bottom of the depositing tank, rendering it impossible to circulate the electrolyte freely. Mr. Cowper-Coles has found the loss of zinc in many cases to amount to 30 per cent.

A plan and sectional elevation of a plant suitable for depositing zinc on iron sheets was shown. Two steel tanks are provided for containing the electrolyte, which is circulated through the regenerating tanks by means of a small donkey pump or a steam injector, the connections being so arranged that the regenerating tanks can be charged and discharged alternately. In the regenerating tanks is placed from time to time zinc dust, which is dissolved by any free acid present. The spent electrolyte is passed through a steam heater before being injected into the bottom of the regenerator; the revivified liquid, as soon as the undissolved zinc dust has had time to settle, is allowed to return to the depositing tanks by gravity. The addition of zinc dust to the electrolyte is the only practical method of keeping the electrolyte in working order, as zinc anodes—whether cast, rolled, amalgamated, or in the form of granulated zinc—fail to keep the solution up to its normal strength. The anodes, which give the best results when working with zinc dust, are lead. The economy effected by the use of zinc dust is considerable, as it can be obtained more cheaply than rolled zinc anodes.

The capacity of the dynamo for such a plant as shown, would be 4,000 amperes at an E.M.F. of 7 volts, the current being conveyed to the tanks by bare copper strip having a sectional area of 1 square inch for every 1,000 amperes.

In the discussion which followed the reading of the paper, it was clear that those who had listened to it regarded it as an extremely valuable addition to their knowledge of the subject; indeed, it is a paper which is fraught with more than ordinary interest to manufacturers whose works exist in those districts where enormous quantities of the sulphate and other salts of zinc are annually run to waste, and the process described seems to provide a means by which this waste may be profitably utilised. It also opens up great possibilities for the utilisation of large quantities of impure oxide of zinc, for which there is apparently no market whatever.

THE APPLICATION OF ELECTRICITY IN BREWERIES.

In a recent issue of the *Wochenschrift fur Brauerei*, there is an important paper which appears to have been read by Otto Görling at the Eighth Convention of German Brewers, recently held at Nuremberg.

The early part of this paper naturally deals with an explanation of the principles of electricity and magnetism, and the modern methods by means of which these are applied to electric light, power transmission, &c. This is, of course, too elementary to find any place in these pages, and we may pass it by and come at once to the remarks made, which have more special interest in connection with the installation of electricity in breweries. We note that the lecturer favours the use of the continuous current inasmuch as it has a great advantage over the alternate current for electro-chemical purposes, and permits the use of accumulators. These are considered to be of great value in brewery work, because the consumption of power and light in a brewery varies between wide limits, and some method of equalisation is desirable. Of course it may be claimed that in loading and using accumulators power is lost, but the lecturer observes that this loss, considering the yearly average, is not as great as when the machines run constantly and are loaded up only moderately during the greater part of the time. He also referred to the decided advantages furnished by accumulators, inasmuch as when voluntary or involuntary stoppages of the machines occur, the supply of current into the wires is not interrupted. In German breweries it seems that continuous current machines are chiefly used, and since the distances are not great, low tensions may be employed.

The atmosphere of breweries is, of course, usually somewhat moist, the higher the potential of the current, therefore, the more difficult the installation and the larger the loss from leakage. Not only are the losses caused by insufficient insulation to be feared, but these losses, by means of the electro-chemical action of the current, show defects, cause interruptions of service, and thereby trouble and large expenditures of money. Even the rules which the Association of German Electricians have formulated for the installation of moist localities, admit the above and contain the following statement:—

"Plants that are placed in moist rooms, for instance in breweries and dye houses, need not conform to the rule that the resistance of the insulation of the whole wiring system to the earth shall be at least $1{,}000{,}000/n$ ohms, &c. But it is stipulated that in installations in moist rooms the conductors must be provided with fire-proof and moisture-proof covering, and so made that a fire on account of leakage of current is totally avoided."

These rules, however, are altogether too lenient, and it is impossible to connect installations of breweries that are executed in that way to a large distributing system, for instance, to a central station in a city. Leakages cannot always be avoided in a moist room with relatively crude service, but these leakages must be minimised by the selection of proper insulation and by clean work, and a normal insulation resistance should be fixed that remains within practically reachable limits.

The tension approved of by the lecturer is 65 volts to 2×110 volts, and after stating this he proceeds to consider how the damp rooms in breweries, such as the cold stores, the fermenting rooms, the malting, barrel-washing, and racking rooms should be installed. His remarks on this subject will be read with interest by most of our readers who are likely to be engaged in such installations.

As conducting materials, rubber, or okonite covered wires, placed on large bell insulators that are cemented in at short intervals, should be used. The iron brackets of these insulators should be zinc-coated, and good insulated wire should be used as binding material. The sockets of incandescent lamps should be provided with strong porcelain bases, to prevent all hygroscopic action. Incandescent lamps must be suspended or affixed in as firm a manner as possible, and portable lamps should be avoided, because we do not possess any material to-day for pipe conduits, which costing little,

will remain intact when handled by brewery help. If portable lamps must be used, then the wires that are already insulated with rubber covering, should either be placed again in another rubber tube, or inserted into a spiral steel-wire tube, in order that any damaging of same may be prevented. The plug contacts should be placed either in a suspended position, or set on the wall, and the latter are to be provided with a cover, to exclude moisture. Hygroscopic materials, such as wood and fibre should likewise be avoided with this apparatus; even material such as hard-rubber should not be applied, because the latter is greatly affected by changes in temperature.

The base of the incandescent lamp should not be affixed to the lamp with plaster of Paris, but with a material that absorbs no moisture. The arrangement of the wires should be such that neither cut-outs nor lead safety fuses are placed in moist rooms; these devices should be affixed to a switchboard located in a dry room, easily reached by the workmen in the cellars, to operate the same.

For this purpose such cellar compartments as shall be served at one and the same time should be provided with separate wires from this switchboard. The reason for this arrangement lies in the fact that even when using waterproof switches and lead fuses in moist rooms, the moisture cannot be kept away from the apparatus or devices for a long time, because the moist air surrounding same penetrates them and deposits itself in the shape of water, whenever there are changes in temperature, on the contacts which are then attacked by the electrolytic action of the current.

In the brew-house, if the construction admits, the best illumination is the arc light, supplemented by incandescent lamps, the latter placed in such locations where the arc light cannot be used on account of obstructions in the shape of apparatus, transmissions, &c. Barley floors and barley cleaning rooms are lighted by means of incandescent lamps, that are especially protected by globes against too much dust accumulation. The lead fuses and switches used, should, if they are located on the floors themselves, be provided with dust-proof covers, in order to prevent risk from fire in case of spark formation. The malt kilns offer great difficulties on account of the high temperature prevalent therein. If possible, incandescent lamps should be placed outside of the room, in niches that are covered with strong glass.

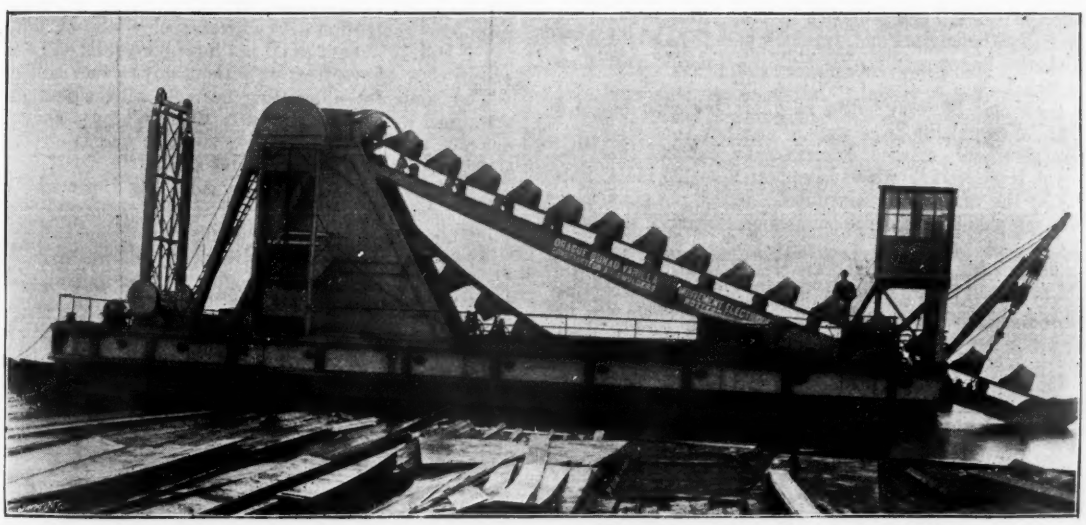
The lecturer presented a calculation of the cost of service and concludes that a dynamo which operates with an efficiency of 85 per cent. can supply 12 incandescent lamps of 16 candle-power each, and that each of these lamps costs 2 pfennigs per hour, according to German conditions. Even this figure can be reduced with the introduction of electric power transmission, which is very simple and which very advantageously and perfectly supersedes the small engines set up for special purposes as well as the heavy power absorbing transmissions.

A high tribute was paid to the value of the electric motor, which is mechanically the simplest power-giving machine. From the shaft, running in two or three bearings, the power is taken at will either by means of rope, belt, chain, coupling, or gear. Parts that move to and fro, as with the steam engines, gas motors, &c., are avoided. The electric motor is, besides, of relatively small weight and requires but a small outlay, with regard to production, maintenance, and service; because its efficiency as compared with that of the steam engine is high, and such efficiency even with a load decreases but very little. The attendance upon an electric motor exacts no special intelligence and care, because the only thing to do is to insert or withdraw a lever. The supplying of oil or the re-setting of the brushes with continuous current motors is to be done only at long intervals, because good machines are provided with automatic or self-oiling bearings, and there is but little sparking with firmly set brushes.

The lecturer was of opinion that the continuous current motor had the same advantages and the same disadvantages as the continuous current dynamo. The alternating current motor, however, differs much more from this current supplying machine. At the same time the lecturer considered that the alternating current energy cannot be stored in accumulators, and that therefore when operating the alternating current motor an alternating current dynamo must likewise be run, that in the case of breweries which are not too expensive, and in which machines are not called upon to run day and night, it is better to use continuous current. It is only in the case of large breweries, where machines run for 24 hours, or where distances of a few miles with large power transmissions are encountered that he decides in favour of the alternating current.

ELECTRICALLY DRIVEN LADDER DREDGER.

The *Genie Moderne* describes a novel dredging vessel of the system Bunau-Varilla, which is working in the river Esla, near Benavente, in Spain, for the purpose of getting ballast for a railway. The dredger has been designed with the object of getting rid of much of the complication of the ordinary dredging machine. In the ordinary machine there are six anchors holding the vessel by as many chains radiating from the vessel, and serving to control it and give it the necessary forward and slewing motions. There is always a great complication of winches, and a number of men are required, as well as a boat for anchor shifting, and the various anchor chains are often hindrances to passing vessels. In the new dredger an entirely different system is followed. On either side of the ladder well is a screw propeller. These push the head of the vessel



from side to side as desired. Near the stern is a hole through the bottom of the vessel, and through this a verticle pile can be driven down into the sea bottom. When this pile is driven, it serves as a pivot upon which the vessel is slewed from side to side. There is another such hole and pile at a distance laterally from the first one. Advance of the dredger is secured by driving the pile in the two pivot holes alternately. As the vessel slews round one pile in one corner of the stern, the opposite corner advances a few feet, and then the pile in this advanced corner is driven, and the next slew of the vessel advances the other corner, and gives a fresh cut for the buckets. We are indebted to the firm of A. F. Smulders, of Rotterdam, the constructors, for the photograph from which our block is taken. The distance apart of the holes obviously governs the amount of advance for each swing of the ship. Other advantages of an electrical dredger, apart from the special arrangement described, are the possibility of placing the generating machinery on shore, and conveying any required amount of power to the vessel, which is relieved of all load of boilers or engines, and carries only the ladder and the actuating machinery. There are numerous cases where this system of dredger working within easy reach of the shore should prove itself exceedingly useful and convenient.

CORRESPONDENCE.

The Insurance of Central Stations.

I have read with much interest your article, page 516, October 23rd, on "The Insurance of Central Stations," also "The Views of a Fire Officer on Central Station Insurance," in the same issue, page 522. I have been struck with the following paragraphs in the report of the fire officer's views:—

1. "The notion that fire risks can be dealt with individually, and upon their own merits, is wholly impracticable. They can only be lumped as a class and dealt with accordingly."

2. "I know many stations that are admirably designed, well looked after, and in which it is difficult to conceive how any serious fire can happen."

3. "On the other hand, there are not a few which are crowded to excess, having wooden flooring saturated with oil surrounding the engines and dynamos, and the switchboards encumbered unnecessarily with highly dried and varnished woodwork."

4. "I should be sorry indeed to guarantee such places a further 10 years' life."

The paragraph marked 4 appears to indicate that the whole of the electric stations have been accepted indiscriminately by the various fire companies. Is this not the answer to the complaint of the fire companies, viz., that the business does not pay?

In my opinion, all the elaborate classifications in the world would not assist a Fire Office, or a Life Office, in accepting everything so classified without distinction. There are, no doubt, such stations as named by "Fire Officer" in paragraph 4, referred to above, and which would not pay at any premium likely to be obtained for the risk. It therefore resolves itself into this: Should the Fire Offices not have declined, say, 10 out of the 60 average stations referred to, and in that case, would not the claims have been reduced very considerably? In other words, if a thorough survey of every station had taken place by a practical electrician and fire surveyor jointly, and all those stations which were of the nature described by "Fire Officer" in clause 3, above referred to, had been declined at any price, the remainder might have proved most lucrative to the Fire Offices, as is admitted by "Fire Officer" in paragraph 2.

I am not surprised, Mr. Editor, that you, in your editorial, should state: "It is difficult to appreciate the argument of the Fire Offices that it is impracticable to deal with stations upon their merits." I agree with you in so far as the dealing with electric stations upon their merits should mean the acceptance only of the good risks, and the absolute declension of the bad risks referred to by "Fire Officer."

In all Life Offices you are probably aware they have a system whereby they medically examine every applicant for insurance, and upon the result of the examination, combined with the family history, depends the acceptance or otherwise of the risk; and we find that many risks are either absolutely declined or 5, 10, or more years are added to the rate if accepted. Others are accepted at ordinary rates. Supposing all were accepted without distinction, would it not be likely to prove a serious loss to the life offices? The same argument, I think, would apply to central stations. It is not because there are 80 central stations, and the central stations are classified as either ordinary, medium, or hazardous risks, and have been taken under a rate of 3s., that they should be taken indiscriminately at that rate, when "Fire Officer" himself admits that the lives of some of these stations are not likely to be even ten years. The rate, therefore, on these (if they were accepted at all) would be fabulous, viz., £10 per cent. plus about 35 per cent. for working expenses.

Trusting my remarks may lead to further discussion on this subject,

W. E. Momson.

Re the Jandus Lamp.

The apparent joy of Messrs. Drake & Gorham, as to the decrease in the manufacture of lamps with open burning arcs, ELECTRICAL REVIEW, No. 985, seems to us to be somewhat premature, as we can state to our great satisfaction, that we have not experienced any decrease in our sales. It is also noticeable in a high degree, that these gentlemen judge in a very autocratic manner with reference to our trial results, without even taking the time to read our explanation carefully. We have not contended that the tests by Messrs. Houston & Kennelly were not impartial; but have treated the matter, not as a question of intensity of light, but as one of illumination; Messrs. Houston & Kennelly have measured the intensity of light, whilst we have measured the illumination, and that these measurings should be difficult (as Messrs. Drake & Gorham assert), we did not find at all. What one understands seems easy; and further, it will be allowed that, whether the flickering is attributable to a longer arc or not is purely a matter of opinion.

That we should have had a sample lamp not properly put together, because inside the globe a small residue had formed (the words "not transparent" were not used), is a purely mythical contention, which does not require any comment. For, if the contention were correct, such a long burning time as 186 and 165 hours could not have been reached; and this will be clear to every expert without any further explanation.

The lamp for alternating current, with closed arc, is, according to Messrs. Drake & Gorham's own assumption, not yet put on the market; so that further explanation about this is at present superfluous.

That also an alternating arc lamp can burn with closed arc is known, but to obtain this it is of course necessary to bring about several artificial results.

From the above it will be clearly shown that Messrs. Drake & Gorham have brought nothing forward which is really to the purpose, or which would serve as information for us; consequently we uphold and maintain our critique as being perfectly correct in every respect.

(Signed) Körtiss & Mathiesen.

Information Wanted.

I shall be very glad if you will answer the following questions, viz.:—(1) Is it necessary to get the sanction of the local authority to take mains over a public road, providing I comply with the Board of Trade regulations. (2) What substance is suitable for lowering the resistance of water (other than sul. acid), preferably of a non-ascetic nature. Thanking you in anticipation,

F. Williams.

[There are many cases where the sanction of a local authority to cross public roads has been dispensed with by persons who have no provisional order or license, but the rights and liabilities of non-undertakers under the section of the Act are summed up in Bower & Webb as follows:—

"(*a*) They may transmit electricity from one part of their own premises to another part;

"(*b*) They may carry electric lines to premises other than their own, if entirely enclosed within buildings;

"(*c*) They may carry electric lines to such other premises, if not so enclosed, with the leave of either (i) private bodies or persons affected, or (ii) where public streets are crossed, by leave of the local authority.

"In (*a*) and (*b*) they are not, in (*c*) they are liable to the provisions of this section. In *c* (ii) they are liable to indictment, &c., as well."

In reply to Mr. Williams's second question, he might use a solution of sulphate of zinc with zinc plates as electrodes. —Eds. Elec. Rev.]

Electricity in Mines.

In Mr. Steavenson's letter of November 6th, he says I do not give any reason for the want of faith that is in me as to the efficiency of compressed air motors.

Mr. Steavenson has already come down to 51 per cent. from the 70 per cent. efficiency which Mr. Kennedy gave. His average now is from 44 to 51 per cent. Mine was from 30 to 50 per cent.; the latter being for the best general practice.

If Mr. Steavenson will refer to D. K. Clark's "Mechanical Engineers' Pocket-Book," p. 575, he will find the following: —"In general practice, the resultant efficiency rarely exceeds 30 per cent." On page 452, giving a special case, he will find the efficiency with reheating given as 50 per cent.; without reheating, 40 per cent.

On page 365 of the "Colliery Manager's Hand-Book" is given the following:—"A very low proportion of the work done in the steam engines is given by the engines using compressed air—not more than from 25 to 30 per cent."

Again, C. H. Hayne, writing in *Cassier's Magazine* for October, and giving figures for some tests of compressing plants, says:—"Only 31·9 per cent. of the stored up power could be realised at the rate per H.P. shown, and only 26·15 per cent. actually was realised."

This was over a test including all the various plant driven by compressed air, rock drills, pumps, and hauling engines.

As regards mines in which safety lamps are used, I do not say that electricity dispenses with careful supervision; but, if the same amount of attention is paid in looking after the electrical plant as is necessitated in keeping the joints, &c., of a compressed air plant in good order, there will be no more danger than there is in using a safety lamp."

H. W. Appleby.

November 10th, 1896.

Made in America.

I have read with interest and approval your last week's leading article on the question of American *versus* English engines for electric tramways, and consider that you have gauged the condition of affairs very accurately. There is no doubt that in many sections of electric tramway work American engineers and appliances are much ahead of the best we can find existing here already; this, of course, is due, for one thing, to the enormous mass of experience gained over there during the past seven or eight years. But no one would have the least fear but that English engineers *can* if called upon, and if given the chance, design and build plant every bit as good as (if not better than) that now so largely introduced from the States. There ought to be no question of patriotism about it; the matter should turn rather upon expense, and it seems absurd to pay heavy freight upon engines, generators, and so forth, that are made quite as well here as in America, and much more cheaply.

However, I know several consulting engineers immersed in traction work who quite intend to see that in future plant shall be bought in England, where it is equally as good, cheap and suitable, as in the States.

Frank B. Lea.

Westminster, *November 9th*, 1896.

Inductive Capacity.

I am free to confess that I expected to see, last week, some comments under above caption on the recently published figures of Mr. Preece's tests on various submarine cables, the more so considering that two of the trinity which constitutes *Die Redaction des Telegrafic Journal* and Electrical Review, are known to be cable experts. How a single core containing heavy Edison-shaped twin conductors in close proximity should give less capacity per nautical mile than lighter single conductors in its own dielectric, and widely separated, surprises me pretty considerably. The explanation seems to lie in the peculiarity of the tests, all the cables with which Mr. Preece compares his new type being measured between wire and earth, while his own is between wire and wire. However this may be, I wish to point out that whether Mr. Preece is right or wrong there is really no need to puzzle one's brains any longer over reducing induction in either overhead wires or submarine cables.

Quite recently I heard of a fellow "made in America," to quote your leading article of last week, who has devised a telephone transmitter by the use of which induction is clean wiped out, and S. P. Thompson, Major-General Webber, and others have, I am told, reported that this is so.

I would be glad to know how many grains of chloride of sodium one must swallow to inwardly digest what we read and learn regarding this multiple microphone, for I am mightily troubled with induction of both sorts.

Right here though, I wish to state that I have not been able to trace any instances of this transmitter having been fixed up in the land of the free, where the mighty Missouri rolls down to the sea.

It is an ill wind that blows nobody good, and if this transmitter shuts off induction right along the line there is a good time coming for cable makers, who can now add still further to the 999 mixtures of foreign substances which go to make up pure G. P. and I. R., with never a thought of bringing down induction. And the relief to the "spot watcher" will be as welcome as an addition to his salary after working ten years for the same screw. No longer will he have to read within one-tenth of a degree more or less—and how conscientiously he strives to make it less by sitting at an angle to the spot, or mistaking the middle of the light beam for the outside edge—so as to bring his result ·34999875, and thus be well under the standard of ·35 microfarads per knot. Electro-statically and electro-magnetically yours,

O. Coe Knight.

Manchester, *December 8th*.

There is Neither Electricity nor Ozone in it.

There is little reason, if any, for the British Electrozone Corporation to be proud of the withdrawal of the proceedings by Messrs. Paterson & Cooper, whose patents they were said to be infringing when they manufactured "Electrozone," *i.e.*, hypochlorite of sodium, by means of the electric current.

It is really amusing to read the letter addressed to the Electrical Review by the British Electrozone Corporation, as if they had any right to apply to the electrical press, or as if they had directly or indirectly anything in common with electricity.

The following is instructive, as it shows the British Electrozone Corporation confessing that electrozone is a misnomer:—

On February 7th, 1896, the British Electrozone Corporation, Limited, of Trafalgar Buildings, Northumberland Avenue, London, applied for the registration of the word "Electrozone" in Class 3 for chemical substances prepared for use in medicine and pharmacy. The Comptroller refused registration on the ground that the mark proposed did not contain any of the essential particulars required as a condition for the registration of a new Trade Mark by Section 64 of the Patents, &c., Act, 1883, as amended by Section 10 of the Patents, &c., Act, 1888, and he declined to proceed with the application. The applicants appealed to the Board of Trade, who referred the appeal to the court. The appeal came on by way of motion by the applicants to require the Comptroller to register the word as a Trade Mark. It appeared from the case on appeal that the article to which the word "Electrozone" *had been applied was sea water or other saline solutions treated by electrolysis, the result being an efficient germ-destroying agent.* By their case the applicants submitted that "Electrozone" had *no reference to the character of the compound or its qualities, as no electricity or ozone was in it;* nor did the word describe anything in connection with the manufacture or use of the article; nor did it convey to the chemist or the general public what the article was.

. . . . . .

Kekewich, J. . . . . I dismiss the motion with costs.

(In the matter of the application of the British Electrozone Company for the registration of a Trade Mark, *Illustrated Official Journal* (*Patents*) Wednesday, August 5th, 1896, No. 396.)

Ozone.

Croydon Electricity Works.

In your current issue we notice your statement that the boiler fittings at above are of our manufacture. So far as we are aware, and judging from the illustrations, our patent boiler mountings and patent valves have not been supplied to these works.

No doubt the error in your article has occurred owing to it having been so general for you to notice our specialities in connection with other electricity works, but as the statement is incorrect in the present instance, we hasten to inform you of this.

For **J. Hopkinson & Co., Limited,**
ROBERT A. HOPKINSON, *Director.*

Huddersfield, *November 7th*, 1896.

International Submarine Memorial.

In the few words which I had said on the occasion of the meeting of the Executive Committee of the International Submarine Telegraph Memorial on Friday October 30th, as reported in your issue of last week, I see a slight error—the insertion of "than" before 1858, which materially alters what I intended to say. The corrected sentence runs thus:—" . . . and if we come to the first Atlantic cable successfully laid, a date considerably later,—1858, is reached."

Kelvin.

[What we printed was exactly in accordance with the manuscript, and we are pleased to insert Lord Kelvin's correction, which, of course, materially alters the sense of what was previously conveyed.—EDS. ELEC. REV.]

INDUCTOR ALTERNATORS.

THE *Elektrotechnische Zeitschrift* for October 15th last contains an article on the subject of patents for inductor alternators. It points out that the English Patent Office, in accepting an application, does not enter into investigations as to the possibility or novelty of an invention, and these well-known facts are the cause of the wide-spread opinion in technical circles that applications for patents in England are never rejected by the Patent Office. This opinion is not correct, for sometimes the applications are either totally rejected, or are only accepted after certain changes in the specifications, or claims have been made; but this is only done if a second party opposes. In these cases the Comptroller-General, after hearing the applicant and the opponent, decides whether the application is to be accepted, rejected, or modified. A case of importance for the manufacturers of dynamos was some time ago brought before the Court as a result of an application for a patent for an alternating current machine of the inductor type by the Oerlikon Company. Mr. W. M. Mordey lodged an opposition on the ground of his patent filed in 1887 for an alternator of similar type with stationary armature and field windings. Thus the question to be settled was whether this type of inductor alternator is to be regarded as covered by Mordey's patent in England. This question, it is pointed out, is also of importance to German manufacturers, inasmuch as it concerns the export of such machines to England, and possibly, also, to the English colonies, and therefore the question is worthy of attention.

The Comptroller's decision is summarised as follows:—The invention relates to alternating current dynamos in which the field magnets and armature coils are fixed, while alternating currents are produced in the latter by the movement of magnetic masses. Many dynamos or alternators of this class have been proposed, but opponent Mordey was the first who patented in England such an alternator having a multipolar field. Applicant seeks to claim a machine of this type, and especially two forms of it—First, a special distribution of the armature coils in relation to the field poles and phases, and second, a peculiar construction of rotary magnet or inductor. As regards the first claim, the construction for monophase machines is identical with Mordey's construction, while as regards polyphase machines it would appear to be an obvious modification. As regards the second claim, attention must be given to the fact that opponent has not drawn special attention in his application to the bow-shaped pole pieces with laminated ends, though the drawings show a rotating inductor without coils, consisting of magnetic and laminated masses which are probably magnetically independent of one another. This arrangement of bow shaped poles, armed at the ends with sheet iron, can in any case only be considered an improvement on Mordey's construction, and not an independent invention. The Comptroller, therefore, decided that the patent could only be sealed if the applicant inserted the following declaration in his application:—"I wish it to be understood that I am aware of the specification of letters patent No. 8,262 of 1887, granted to Mordey, and I do not claim anything described and claimed therein."

The article concludes as follows:—"It is apparent from this judicial decision that the English Patent office regards this type of inductor machines as covered by Mordey's patent.

THE EARL'S COURT TO MANSION HOUSE UNDERGROUND ELECTRIC RAILWAY SCHEME.

SIR BENJAMIN BAKER has presented to the Metropolitan District Railway Shareholders' Association an elaborate report with estimates for the construction of the proposed electric express line to the City under the existing District Railway from Earl's Court to the Mansion House. Some of the arrangements as to the working of the junction and the changing of engines are subject to reconsideration, but in the main the scheme is complete, and it has been decided to prepare a Parliamentary bill with the utmost despatch. In his report to the Shareholders' Association, Sir Benjamin Baker states:

The proposed express line as laid out by me, after detailed consideration of all the conditions of the case, will commence by a junction with the main line of rails of the District Railway, about midway between Earl's Court and Gloucester Road Stations, and, curving to the right, will run under the Cromwell Road for a distance of about 300 yards on a descending gradient of 1 in 42, when it will be at a sufficient depth to pass under the side wall of the covered way of the District Railway near to the west end of Gloucester Road Station, from whence it will continue to run under the District Railway to the terminus at the Mansion House.

Having been engaged personally on the construction of the District Railway, I have an intimate knowledge of the soil through which the electric line tunnels would have to be driven, and of the works of the District and other railways, sewers, and buildings over or near to the proposed line. After further detailed study, I confirm the opinion expressed at the board that, under proper engineering supervision, and with experienced contractors, the proposed works can be carried out without interference with the District Railway or risk of damage to any works or property in the neighbourhood. The tunnels throughout would be in perfectly solid and dry London clay, which is the most suitable soil for such works.

It is proposed that there should be one intermediate station between Earl's Court and the Mansion House at Charing Cross. At Earl's Court the existing platforms would be used by the Electric Railway passengers. At Charing Cross the platforms for the latter would be 63 feet below the present District Railway platforms, or 78 feet below street level, and at the Mansion House the corresponding depths would be 71 feet and 95 feet respectively. Hydraulic lifts and stairs would be the means of communication between the platforms of the Electric Railway and District Railway at Charing Cross and Mansion House, and above that level the existing entrance and exit stairs, slightly modified, would be common to passengers by both lines.

In the working of the line the steam locomotives and electric locomotives would change places at or near Earl's Court Station, and the most convenient way of effecting this has involved a great deal of consideration and discussion. By a readjustment of the existing lines at Earl's Court and a modification of the traffic arrangements it would be possible to change engines at the Earl's Court platforms, but as this would indisputably involve some inconvenience and delay to the District traffic, I have considered it necessary to provide an alternative in which the existing arrangements at Earl's Court would be unaffected. This is attained by constructing the first 176 yards of line under the Cromwell Road as a brick covered way of sufficient size to admit the shunting of a steam locomotive, so that the change of engines might take place clear of District lines. There is no difficulty in this from an engineering or traffic point of view. To meet Board of Trade requirements, as the change of engines would take place on a gradient, the ordinary air-brakes would be supplemented by a rack railway brake on the rear carriage of each train, so that no running away could occur, even if the air-brakes failed. As regards the time element, I doubt if there would be much difference between changing engines on the District lines at Earl's Court Station and on the Electric line a little further east, as the extra stop would be compensated for by the increased facilities of exchange at the latter point and by the stop at Earl's Court being reduced, say, from 1½ minute to twenty seconds. However, my plans and estimates

provide for either alternative, and the decision may be left for the future.

No property would have to be acquired for any of the preceding works, but in certain places easements would have to be acquired independently of that which could be granted by the District Railway Company. This question, though probably a small one as regards cost, is a very important one from a legal point of view, as there are many novel questions to be dealt with, and any serious error might imperil the bill.

I have prepared the estimate in the present case in two sections, the first of which includes the items necessarily set forth in the Parliamentary estimate, and the second those which in ordinary cases would be provided for out of the borrowing powers.

I.—Cost of Railway Works and Land.
Length of Line Five Miles (Double).

Tunnelling and shafts	£745,440
Permanent way, &c.	29,500
Permanent way for sidings	1,360
Stations	25,000
Contingencies 10 per cent.	80,100
	£881,400
Land and buildings, including easements, say ...	118,600
Total	£1,000,000

II.—Cost of Electrical Installation, Rolling Stock, &c.

Electrical installation capable of working eight trains on the line at the same time if required; rolling stock, consisting of 10 full-powered electric locomotives, 80 long American-type carriages; also repairing shops and depôt for same, and hydraulic installation and lifts at stations	£264,000
Professional charges, Parliamentary and other expenses, and interest during construction, say, 15 per cent.	189,000
Total	£1,453,000

THE NEW MOTOR CARS ACT.

As the Locomotives on Highways Act will come into operation to-morrow, the Local Government Board has, as already intimated in our columns, issued to the County Councils and other local authorities the Regulations which are to be observed with respect to the use of light locomotives, their construction, and the conditions under which they may be used. These are accompanied by a Circular from the Board, explaining the provisions of the Act and the Regulations. The following are the principal passages in the document:—

"Sub-section (1) of Section 1 of the Act provides that the enactments mentioned in the Schedule, and any other enactment restricting the use of locomotives on highways, and contained in any public, general, or local and personal Act in force at the passing of the new Act, shall not apply to any vehicle propelled by mechanical power if it is under three tons in weight unladen, and is not used for the purpose of drawing more than one vehicle (such vehicle with its locomotive not to exceed in weight unladen four tons), and is so constructed that no smoke or visible vapour is emitted therefrom except from any temporary or accidental cause. Vehicles so exempted, whether locomotives or drawn by locomotives, are in the Act referred to as light locomotives. In calculating for the purposes of the Act the weight of a vehicle unladen, the weight of any water, fuel, or accumulators, used for the purpose of propulsion, is not to be included. A light locomotive is to be deemed to be a carriage within the meaning of any Act of Parliament, whether public, general, or local, and of any rule, regulation, or bye-law made under any Act of Parliament, and, if used as a carriage of any particular class, is to be deemed to be a carriage of that class, and the law relating to carriages of that class is to apply accordingly. Consequently if, *e.g.*, a light locomotive is used as a hackney carriage, all statutory provisions and bye-laws with regard to hackney carriages in force in the place in which the light locomotive is used will apply to it.

"Under Section 4 of the Customs and Inland Revenue Act, 1888 (51 and 52 Vict., c. 8), certain Excise duties are payable for every carriage and every hackney carriage as thereby defined. The definition of carriage includes any carriage, except a hackney carriage, drawn or propelled upon a road or tramway by steam or electricity, or any other mechanical power, but does not include a waggon, cart, or other such vehicle which is constructed or adapted for use, and is used, solely for the conveyance of any goods or burden in the course of trade or husbandry, and whereon the Christian name and surname and place of abode or place of business of the person, or the name or style and principal or only place of business of the company or firm keeping the same, are visibly and legibly painted in letters of not less than 1 inch in length. Hackney carriage is defined by the Section as meaning any carriage standing or plying for hire, and including any carriage let for hire by a coachmaker or other person whose trade or business it is to sell carriages, or to let carriages for hire, provided that such carriage is not let for a period amounting to three months or more. The duties imposed by the Section will be payable for light locomotives which are carriages or hackney carriages as above defined, but besides these, where a light locomotive is liable to duty, either as a carriage or as a hackney carriage, under Section 4 of the Customs and Inland Revenue Act, 1888, an additional Excise duty will, on and after January 1st next, be payable for it under Section 8 of the new Act, at the following rate, namely:—If the weight of the locomotive exceeds one ton unladen, but does not exceed two tons unladen, £2 2s.; if the weight of the locomotive exceeds two tons unladen, £3 3s. Every such duty must be paid together with the duty on the license for the locomotive as a carriage or a hackney carriage. The duty will be collected by the Inland Revenue Commissioners, and be paid with the proceeds of the duties on local taxation licenses into the Local Taxation Account.

"Article I. of the Regulations provides that in the Order the expression 'light locomotive' shall mean a vehicle propelled by mechanical power which is under three tons in weight unladen, and is not used for the purpose of drawing more than one vehicle (such vehicle with its locomotive not exceeding in weight unladen four tons), and is so constructed that no smoke or visible vapour is emitted therefrom except from any temporary or accidental cause. In calculating for the purposes of the Order the weight of a vehicle unladen, the weight of any water, fuel, or accumulators used for the purpose of propulsion is not to be included.

"Article II. prohibits any person from causing or permitting a light locomotive to be used on any highway, or from driving or having charge of a light locomotive when so used, unless certain conditions are satisfied. These conditions require that the light locomotive, if it exceeds in weight, unladen, five hundredweight, shall be capable of being so worked that it may travel either forwards or backwards, and relate to the width of the light locomotive, the smoothness and width of the tyres of the wheels, and to the brakes. They also require that the light locomotive shall be so constructed as to admit of its being at all times under such control as not to cause undue interference with passenger or other traffic on any highway, that the light locomotive and all its fittings shall be in such a condition as not to cause, or to be likely to cause, danger to any person on the light locomotive or on any highway, and that there shall be in charge of the light locomotive, when used on any highway, a person competent to control and direct its use and movement.

"Regulation (6) of Article I. requires that the name of the owner, and the place of his abode or business, and the weight of the light locomotive unladen, shall, in the case of a light locomotive drawing or constructed to draw another vehicle, or constructed or used for the carringe of goods, be painted in one or more straight lines upon some conspicuous part of the right or off side of the light locomotive in large legible letters, in white upon black or black upon white, not less than one inch in height. Moreover, the weight of the light locomotive must in every case, where unladen it amounts to a ton and-a-half or upwards, be painted on it in a similar manner. It will be observed that this Regulation will not extend to all light locomotives. So far as it relates to the name of the owner and the place of his abode or business, it will only apply to the case of any light locomotive drawing, or constructed to draw, another vehicle, or constructed or used for the carriage of goods, whilst as regards the weight of the light locomotive, it will apply to these cases, and also to the case of any light locomotive weighing a ton and a half or upwards.

"Section 2 of the Act directs that during the period between one hour after sunset and one hour before sunrise the person in charge of a light locomotive shall carry attached thereto a lamp so constructed and placed as to exhibit a light in accordance with the Regulations to be made by the Board. Regulation (9) of Article I. of the Order accordingly makes it one of the conditions upon which a light locomotive can be used on a highway that the lamp to be carried attached to it in pursuance of Section 2 of the Act shall be so constructed and placed as to exhibit, during the period between one hour after sunset and one hour before sunrise, a white light visible within a reasonable distance in the direction towards which the light locomotive is proceeding or is intended to proceed, and to exhibit a red light, so visible, in the reverse direction. The lamp must be placed on the extreme right or off side of the light locomotive in such position as to be free from all obstruction to the light. The Regulation will not extend to bicycles, tricycles, velocipedes, or other similar machines. Section 85 of the Local Government Act, 1888, contains provisions as to the lamp to be carried by these machines.

"Article III. directs that any vehicle drawn by a light locomotive, except where the light locomotive travels at a rate not exceeding four miles an hour, must have a break of a prescribed efficiency, and requires that the vehicle shall carry upon it a person competent to apply the brake efficiently.

"By Article IV. regulations are made with which every person driving or in charge of a light locomotive, when used on any highway, is required to comply. These regulations are intended to prevent injury being caused by any light locomotive to any person, carriage, horse, or cattle, or to any goods conveyed in any carriage on a highway, and also to prevent obstruction of the highway by light locomotives or vehicles drawn by them, or undue interference with the ordinary traffic. The usual rules applicable where carriages meet or pass each other are required to be observed in the case of light locomotives, and any person driving or in charge of a light locomotive must, on the request of any police-constable, or of any person having charge of a restive horse, or on the constable or person putting up his hand as a signal for that purpose, cause the light locomotive to stop, and to remain stationary so long as may be reasonably necessary. The provision in Section 3 of the Act that every light locomotive shall carry a bell or other instrument capable of giving audible and sufficient warning of the approach or position of the carriage is supplemented by Regulation (7) of Article IV., which directs that the person driving or in charge of the light locomotive shall, whenever necessary, by sounding such bell or other instrument, give audible and sufficient warning of the approach or position of the light locomotive.

"Section 4 of the Act directs that no light locomotive shall travel

along a public highway at a greater speed than 14 miles an hour, or than any less speed that may be prescribed by regulations of the Board. Article IV. directs that a person driving, or in charge of, a light locomotive when used on any highway shall not drive it at any speed greater than is reasonable and proper, regard being had to the traffic on the highway, or so as to endanger the life or limb of any person, or to the common danger of passengers. Regulation (2) of the Article further provides that he shall not under any circumstances drive the light locomotive at a greater speed than 12 miles an hour. If the weight of the light locomotive unladen is one ton and a half, and does not exceed two tons, it shall not be driven at a greater speed than eight miles an hour, or if such weight exceeds two tons, at a greater speed than five miles an hour."

THE INTERNATIONAL SUBMARINE TELEGRAPH MEMORIAL.

Meeting of the Committee.

A meeting of the General Committee was held on Tuesday, November 10th, at Winchester House, the Marquis of Tweeddale presiding, to receive the report of the Executive Committee as to the resolutions passed, subject to confirmation, at their meeting on October 30th.

Mr. Geo. R. Neilson (the hon. secretary) having read the minutes of the meeting held on October 6th,

The Chairman said it was agreed at the meeting, the minutes of which had just been read, that whatever was done by the Executive Committee would require rectification by the General Committee. Hence this meeting had been convened. The Executive Committee met on October 30th, and there were present a considerable number of gentlemen representing that committee, and the following resolutions were adopted:—

"That it is desirable to establish a Memorial to the late Sir John Pender, G.C.M.G., to commemorate the leading part he took in the establishment and development of submarine telegraphy and in its extension throughout the world."

"That measures be taken for promoting, in the year 1901, a general International Memorial recording the Jubilee of International Submarine Telegraphy."

These resolutions had been circulated among the committee, and expressions of opinion were invited on the part of those who might be unable to be present at this meeting. Sixty-three members of the General Committee, among them many prominent men, all agreed to the resolutions, with two exceptions—Sir David Salomons and Sir Courtenay Boyle. Both those gentlemen approved of the second resolution but were unable to approve of the first. He (the Marquis of Tweeddale) gathered from Sir Courtenay Boyle's letter that he would have preferred the original suggestion, *i.e.*, that there be a submarine memorial associated with the names originally mentioned. Mons. Delarge, of the Belgian Posts and Telegraphs, approved the second resolution, but with regard to the first, he considered the names originally proposed should be associated with any memorial. With these exceptions the resolutions were approved by gentlemen unable to be present. The principal business of the meeting was to invite expressions of opinion on the part of those present.

There being no attempt on the part of gentlemen present to speak, the resolutions were put to the meeting and approved.

The Chairman said that intimation would now be conveyed to the Executive Committee that the resolutions had been adopted by the General Committee. They would then proceed at once to obtain subscriptions and carry out the object set forth in the resolution. It was proposed to hold a meeting of the executive on Monday, and he hoped from that day onwards the business of the committee would be prosecuted with the utmost energy and vigour, and that they would soon be able to report the amount of subscriptions, and the manner in which those subscriptions were proposed to be used.

Mr. Baines said he supposed those who subscribed at the present time would be subscribing to Sir John Pender's memorial and nothing else.

The Chairman replied, yes, certainly. He thought it would be premature to obtain subscriptions so long beforehand for the 1901 memorial. That the subscriptions would go to the Pender memorial would be very clearly indicated in a circular which it was proposed to send out.

Mr. J. G. Griffiths moved a vote of thanks to the chairman.

The Chairman: Allow me to say it is a labour of love.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Telephone Trunk Line System in Great Britain. By J. Gavey, member. (Paper read November 12th, 1896.)

In the early days of the telephone, whilst various local systems were being developed, and before the idea of providing trunk lines between neighbouring towns had been matured, the question of long-distance telephony received careful consideration. The pioneer experimenters at once found themselves face to face with the numerous troubles, generally ascribed to induction, which rendered speech impossible on single wire circuits during the busy telegraphic hours of the da and very difficult on such metallic loops as could be made up from existing telegraph circuits. In a paper read before the Physical Society on January 19th, 1878, Mr. Preece described the various causes to which these disturbances were due, and he suggested a method of screening a single wire circuit both from electrostatic and electro-magnetic induction. He also pointed out the true solution of the difficulty, *i.e.*, the use of metallic circuits for telephonic purposes —a practice adopted by the Post Office from the first, and one that has been consistently urged as necessary if a really efficient telephonic service is sought. Prof. Hughes continued the subject in his paper, read before the Institution on March 12th, 1879, in which he described the method of revolving the two wires of a metallic loop to obtain a practical balance. In a subsequent paper read before the British Association in 1885, Mr. Preece pointed out the merits of copper as a conductor, and in 1887 he enunciated the K R law in a paper read before the Royal Society.

The following are the theoretical principles involved in the erection of balanced telephone circuits:—

When two complete circuits, either wholly metallic or partly metallic and partly earth, are placed in juxtaposition, each is subject to the following interferences on the establishment, the cessation, or the variation in the volume of a current of electricity in the other:—

1. Induced currents due to electro-magnetic induction.

If two circuits or portions of circuits be contiguous to one another, then, on establishing a current in No. 1 circuit (fig. 1), a certain

Fig. 1.

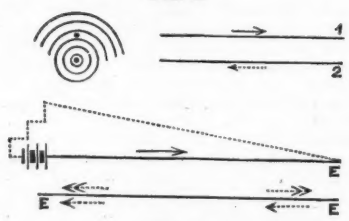


Fig. 2.

number of magnetic lines of force cut No. 2, and a current of brief duration is observed in the latter; and, disregarding direction for the present, corresponding results are observed on the increase, the cessation, or the diminution of the current in No. 1.

2. Induced currents due to electrostatic induction.

Electrostatic induction induces a momentary redistribution of electrification in neighbouring wires, the result being the passage either transversely or longitudinally of currents of short duration. The cessation of the primary current results in momentary induced currents in the reverse direction to the former.

3. If a single wire with an earth return be used, in addition to the above results, leakage from the earth plates and stray currents from other electrical circuits, or from the earth itself, enter the circuit. This aspect of the case may, however, be disregarded at present, for in practice trunk circuits always consist of metallic loops.

If we consider the combined effects of electro-magnetic and electrostatic induction from a single-wire circuit with an earth return—first on a similar circuit, and then on a looped or balanced circuit—we get the results, on the closing or the increase of the current in the primary circuit, which are illustrated in fig. 2, where the continuous arrow, ———>, shows the primary current, the dotted arrows, ·····>, the induced current due to electro-magnetic induction, and the double-barbed arrows, ·····>>, that due to electrostatic induction.

Fig. 3.

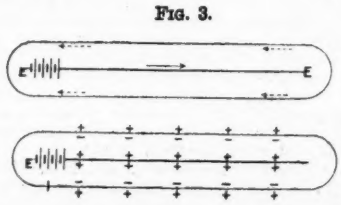


Fig. 4.

The reverse results are observed on the breaking or diminution of the current in the primary circuit. It will be observed that in unbalanced earthed circuits the current due to electro-magnetic induction is opposite to that in the primary on closing the latter, whilst that due to electrostatic induction is in the same direction as the electro-magnetic induction current at the battery end, and in the opposite direction at the far end. Thus, at one end of such a circuit, a disturbance due to the sum of the two currents is observed, whilst at the other end one due to the difference alone is seen.

In the case of the balanced circuit, if all the conditions for silence indicated below are realised, the result of the electro-magnetic induction is that similar potentials are developed along both sides of the loop; the single-barbed dotted arrows (fig. 3) showing the direction only that the current would flow in either branch if, owing to defective balance, the potential in the other were reduced.

The electrostatic effect will depend on the condition of the circuit. If the primary or disturbing circuit be perfectly insulated, and if it be disconnected at the far end, or if it be terminated in a condenser, and if the insulation of the secondary be extremely high, minute currents cross the conductor transversely so as to effect the redistribution illustrated by + and − signs in fig. 4; no currents in a longitudinal direction being developed. If, however, the disturbing or primary circuit be to earth, or if it consist of a neighbouring loop, minute longitudinal currents in the direction shown by the double-barbed arrows in fig. 5 actually circulate.

The combined effects on a balanced loop with the resultant earth in the centre of each wire are illustrated in fig. 5A.

With open wires, however, leakage always takes place over the insulators; hence a much larger static charge is accumulated than with a perfectly insulated secondary; the above conditions are subject to variation, and an actual flow of current in each arm takes place, the direction of which is dependent on the distribution of the leakage, or the position of the resultant earths.

Fig. 5.

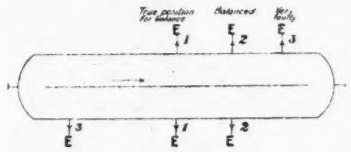
Fig. 5A.

The conditions which are necessary to obviate interference, due to the above causes, between two neighbouring circuits, one of them at least being a metallic loop, are the following. For practical purposes, each circuit which has great length compared to its depth is considered to consist of two sides alone, the ends being negligible.

1. Each of the wires of one loop should maintain throughout the same, or an average equal, distance from each of the wires of all neighbouring loops.
2. The two conductors of each loop should be of the same material.
3. They should have the same conductivity.
4. Each half of the circuit, including apparatus in direct circuit, should possess the same coefficient of self-induction.
5. They should have similar electrostatic capacities.
6. They should have the same degree of insulation, whether high or low.
7. The resultant faults due to loss of insulation should be in the centre of each wire of the loop; but if not there, each should occupy similar positions at equal distances electrically from the extremities.

The necessity for the above conditions is obvious when it is considered that the induction from all neighbouring wires causes constant variations of potential and local currents to circulate along each wire, which must not affect the telephones at either end. Thus, any difference in electro-magnetic inertia, resistance, or capacity between the two arms of a circuit will cause currents to traverse the terminal telephones. With a symmetrical circuit these two telephones

Fig. 6.



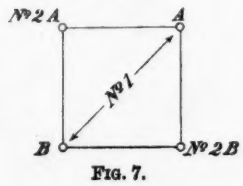


Fig. 7.

occupy absolutely neutral positions at opposite extremities of the circuit, and, if each telephone be wound differentially, and be perfectly balanced, earth may be applied at the centre of each instrument without creating disturbance; whereas, if earth be applied at any other point in the circuit, even at the point where the line wire joins the telephone, the disturbance from neighbouring wires becomes at once marked. Again, any two points of equal potential in the circuit can be bridged without creating disturbance, which means that any number of telephones or indicators may be placed in multiple arc across the balanced wires without upsetting the balance.

Conditions 1 to 5 are readily met, and, once attained, they are stable. No. 6 is more difficult to ensure, for the insulation of either arm of a loop may at any time be lowered by innumerable accidental causes, so that the most careful attention to maintenance is necessary to remove this source of trouble. No. 7 is at times a source of considerable difficulty, especially in the case of telephone trunks erected on poles carrying high-speed Wheatstone wires, when the latter are worked with shunted condensers. Thus, in fig. 6, with the resultant earths at points 1, points 2, or at other symmetrical positions, the circuit is silent; but with positions 3 disturbance becomes evident, for the currents entering at these points traverse the telephones in establishing the electrostatic redistribution.

Normally, the currents due to electro-magnetic induction would be more considerable than those arising from electrostatic induction in a single wire circuit with an earth return. Experiments made between Newport, Cardiff, Swansea, and Haverfordwest, between ordinary parallel wires, under certain conditions, gave the ratio between the two as 9,096 : 306 at the battery end, and 9,096 : 153 at the far end; and the disproportion would be still more marked in a loop. Notwithstanding these facts, it is far easier with open wires to balance magnetic than static disturbance, as the conditions necessary to ensure the former are more readily controlled. This is illustrated by a simple experiment with a high speed transmitter working an ordinary telegraphic circuit, attached to the same poles as a balanced loop. With the telegraphic circuit to earth, in the usual manner at the far end, and a current of 30 or 40 milliamperes, the balanced loop may be practically silent. Add a shunted condenser, or disconnect the far end of the telegraph circuit, and disturbance may become most marked. The effect is much greater than would be accounted for by the mere fact that in the extreme case of the far end being disconnected, the average potential of the disturbing line is as a maximum doubled throughout. The fact is that when the primary circuit is disconnected, or a shunted condenser is fitted at the extremity, the rise and fall of potential is practically instantaneous, and the effect on the telephone circuit is at its maximum; whereas, with the conditions for simple working, the electro-magnets of the receiving instrument cause a flattening of the current-curve, and the rise and fall of potential is too slow to injuriously affect the telephone.

The methods of construction of telephone trunk lines differ but slightly from those adopted in the erection of ordinary telegraph lines, the principal difference arising from the necessity for providing the balanced circuits referred to above.

Taking first the simple case of two contiguous metallic circuits, if they be arranged so that the two arms of each loop are at diagonally opposite angles of a square (fig. 7), then the condition No. 1 is

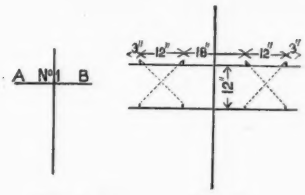


Fig. 8.

Fig. 9.

observed, and the circuits are balanced for distance whether the wires are run straight or whether they revolve; and in a similar manner a loop on a horizontal arm (fig. 8) is balanced against a single wire on a saddle with an earth return, so long as the single wire is at the apex of an isosceles triangle, of which the loop forms the base. With this exception, to obtain a balance between one loop and a second circuit external to it, whether metallic or with earth return, the wires of each loop must revolve uniformly the one round the other. In underground work this revolution is a uniform spiral, but with open work the wires simply change their positions regularly on each successive pole. In England, the method adopted is almost uniform, and it consists in continuous changes of position, every wire being moved transversely at an angle of 90° at each pole, so that a complete revolution is effected in every four spans. Other methods of crossing have been adopted on the Continent, but the above is, perhaps, the most simple way of achieving the end in view. In some cases the wires are run parallel and crosses introduced at intervals to obtain an approximate balance.

The present practice is to erect four wires on arms 48 inches long, divided as shown in fig. 9, the arms being fixed on the poles 12 inches apart from centre to centre. Thus two arms provide space for four metallic circuits, the four wires on each side of the pole forming a section of a 12-inch square, the diagonal wires in these squares being taken up by each circuit.

(To be continued.)

LEGAL.

Hoylake Gas Company and Electric Lighting Powers.

On Saturday in last week, Mr. Lawrance, Q.C. (with him Mr. T. R. Hughes), asked Mr. Justice Kekewich, sitting in the Chancery division of the High Court of Justice, to sanction a proposal to add to a Gas and Water Company's powers, permission to provide for electrically lighting their district. He made the application, he said, under the Companies Memorandum of Association Act of 1890, on behalf of the Hoylake and West Kirby Gas and Water Company, Limited, who at present supply the district simply with gas and water, but by the general desire of the inhabitants it was proposed to extend those powers to electrically lighting the streets. The debenture holders in the company, he added, had consented to the suggested extension, and the debentures were of merely a nominal amount of some £500,

as testified by the secretary in an affidavit, and these would be dissolved in the ordinary course of business at the next monthly meeting of the directors on the 10th inst.

His Lordship having made some enquiries into the details, referred to the district registrar the ascertainment and certification of certain technicalities being complied with, and sanctioned the alteration, upon the company undertaking, in the event of their obtaining Parliamentary powers to supply electricity within 3 months, afterwards to apply to the Board of Trade for sanction to change the name of the company to one suggesting that they supply electricity as well as gas and water.

General Electric Power and Traction Company *v.* Lewis.

In the Chancery Division of the High Court on Thursday last week before Mr. Justice Chitty, this case came on for hearing on a motion for judgment. This was a vendor's action for specific performance of a contract for the sale of a leasehold factory and certain plant and effects situate at Millwall. The company was in process of being wound up voluntarily, and the agreement for sale was made between the liquidators and the defendant, the purchase price being fixed at £7,500. The sanction of the Court was obtained to the purchase but the defendant had refused to complete, hence the present action.

His Lordship gave judgment for the plaintiffs in the usual form.

London Health Electrical Institute, Limited.

The petition of R. O. Hearson, Limited, for an order for the winding up of the London Health Electrical Institute, Limited, came before Mr. Justice Vaughan Williams in the Companies' Winding-up Court on Wednesday.

Mr. Waghorn, for the petitioners, said that the respondent company was indebted to his clients in £246 16s. 4d., the amount of principal and interest due on certain bills of exchange; and the petition states that they had not paid, and that the company was insolvent.

Mr. Butcher, for the debenture holders, opposed the petition. It was absolutely idle to wind up the company. Its assets were of the most trifling amount, far less than sufficient to pay the debenture holders, and there was no possibility of anything being saved for the unsecured creditors.

Mr. Waghorn said his answer to that was in one of the affidavits in which it was stated that this was a one-man company, and that if the affairs of the company were properly investigated, it would be found that the creditors were fully indemnified.

It was then arranged that the petition should stand over for a fortnight.

Inrig & Chester, Limited.

In the High Courts on Wednesday, before Mr. Justice Vaughan Willians, sitting as an additional judge of the Chancery Division, the petition of Alexander Shanks & Son, Limited, for a compulsory order for the winding-up of Inrig & Chester, Limited, electrical and mechanical engineers, Hackney Wick, came on for hearing.

Mr. Powell, for the petitioners, said his clients were creditors, and the sheriff was in possession for two execution creditors, and the debenture holders had put in a receiver.

There being no opposition, his Lordship made the usual order, and suggested that the sheriff should retire, and that that would be without predjudice to the rights of anybody.

Houldsworth *v.* Priestley.

In the Queen's Bench Division, on Monday last week, before the Lord Chief Justice and a special jury, an action was brought by Robert Martin Houldsworth, a financial agent, of London and Halifax, against George Frederick Priestley, an engineer, of Halifax, to recover between £600 and £700. The plaintiff and defendant, it appeared, were interested in a series of patents, one of which was a scheme for turning town refuse into electric light, which was some time ago tried at Halifax. The case referred to a patent for improvements in silk-combing, and a scheme for amalgamating some of the great silk spinning firms of Yorkshire into one huge concern for the working of the patent. Judgment was given for the plaintiff for £330, and the counter-claim was referred to an accountant. Pending the inquiry a stay of execution was granted, the money being paid into court.

BUSINESS NOTICES, &c.

Acetylene.—The Acetylene Illuminating Company, Limited, of 63, Queen Victoria Street, has issued a pamphlet on carbide of calcium and acetylene gas. There are general comments on the gas, generators for acetylene, first application of ditto, value for lighting, price, also a lengthy report by Professor Vivian B. Lewes.

Administration Order.—In the Southampton County Court last week, an administration order was made on behalf of George Ernest Taylor, an electrician, living at the Hearts of Oak, Hill Street, Southampton. The debts amounted to £29 15s. 4d. Payment is to be made at the rate of £1 per month.

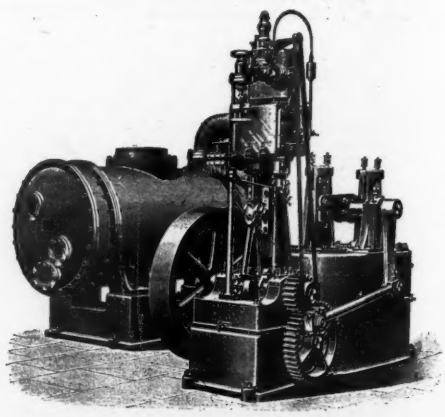
Electrical Wares Exported.

Week Ending Nov. 10th, 1895.	£	s.
Adelaide. Teleg. mtl....	559	0
Amsterdam	100	0
Atlantia. Teleg. cable	15,360	0
Bahia. Teleg. mtl. ...	108	0
Bombay	45	0
Calcutta	26	0
Cape Town	52	0
Copenhagen	135	0
East London	510	0
„ Elec. pump	244	0
Flushing	100	0
Freemantle. Teleg. mtl.	574	0
Hong Kong	16	0
Launceston. Teleg. mtl.	20	0
Lisbon	32	0
Lyttleton	6	0
Madras	70	0
Melbourne	721	0
„ Teleg. mtl. ...	49	0
Oporto	11	0
Perth	125	0
Rotterdam	16	0
Shanghai	643	0
Sydney	158	0
Wellington	57	0
Yokohama	4,652	0
Total	£24,389	0

Week Ending Nov. 10th, 1896.	£	s.
Bangkok	307	0
Boca. Teleg. mtl. ...	209	0
Bombay	390	0
„ Teleph. mtl. ...	19	0
Buenos Ayres	971	0
Calcutta	142	0
Cape Town	448	0
Colombo	41	0
Durban	1,291	0
East London	1,121	0
Flushing	88	0
Fremantle	121	0
Hirgo	42	0
Hong Kong	34	0
Jamaica. Teleg. mtl. ...	29	0
La Plata. „ „ ...	246	0
Malta	70	0
Shanghai	375	0
Singapore	60	0
„ Teleph. stores	12	0
Sydney	230	0
Wellington	193	0
„ Teleph. mtl.	493	0
Yokohama	87	0
Total	£7,118	0

Auction Sale.—On Friday, November 20th, at Foots Cray Place, near Sidcup, Kent, Messrs. Christie, Manson & Woods will offer for sale by auction the nearly new electric lighting plant supplied to the late Sir John Pender by Messrs. Verity. Further particulars of the plant are given in our "Official Notices."

Croydon Condensing Plant.—The condensing plant at Croydon Electric Lighting Works, which we said, last week, had been supplied by Messrs. Browett and Lindley consists of a vertical tandem compound engine having cylinders 5½ inches and 9½ inches × 8 inches stroke, to run at 200 revolutions per minute as a maximum, and working the air pumps by means of a pinion and spur wheel, the latter carrying a crank pin, from which a connecting rod takes on to a lever keyed to a rocking shaft mounted on bearings above the pumps, and working same by a wrought-iron lever. The air pump is 10 inches diameter and 10 inches stroke. The circulating pump 19 inches diameter × 10 inches stroke. Both pumps are lined with gun-metal, secured with delta metal studs and nuts, so as to be easily removable when reboring or repairs. One of the main features of this plant is, that all the parts are perfectly accessible, and consist only of such parts as are generally understood by ordinary engine drivers. The pumps



being vertical, also have a high efficiency, and being quite clear of all other parts, are easily open for examination or repairs. The plant can be run at any speed required, according to the load, and is fitted with an Acme governor, just to prevent any possible running away of the engine in case of breakage of the water, or of the pipes. The engine itself of course exhausts into the surface condenser, which consists of a cast-iron shell fitted with Muntz metal tube plates, in which the solid drawn brass tubes are secured by screwed glands and tape packing, one end of each pipe being secured by a collar, and the other end left free to allow of expansion through the gland. The condenser has 800 square feet of surface, and is capable of easily condensing 11,000 lbs. of steam per hour.

Change of Address.—Messrs. L. Andrew & Co., agents for W. T. Henley's Telegraph Works Company, Limited, at Manchester, have removed from 21, Cannon Street to larger premises at 2, Carr Street, Blackfriars, Manchester.

Catalogues.—The Allgemeine Elektricitäts-Gesellschaft, of Berlin, whose representatives in this country are the Electrical Company, Limited, have recently issued an excellent catalogue, nicely bound, which contains their illustrated lists Nos. 74 to 92. The book, which is in English, opens with a very full set of indexes to the various price lists of the company. We have not space to notice the contents in detail, but among the various articles described, many of which are illustrated, we observe dynamos and electric motors for direct current, with accessories and spare parts; dynamos and electric motors and transformers for three-phase and single-phase alternating current; self-focussing arc lamps, lanterns, &c.; lamp-holders; accumulator apparatus; measuring and testing instruments, electricity meters, and electric clocks; lever switches, single, double, and treble pole; insulation and installation material for electrical conductors; bare and insulated copper wire and cable; flexible cords; dynamo and resistance wires; India-rubber and gutta-percha goods; stabilit, micanite, and mica; safety fuses and accessories for high and low tension; lightning arresters; switches of various types; switch-boards; lead-covered cable; theatre and ship electric lighting apparatus; apparatus for electrically lighting vehicles; A.E.G. incandescent lamps. These few items will give an idea of the ground covered by these selections from the company's lists. A thumb index conveniently separates the various lists. The book is a very useful production.

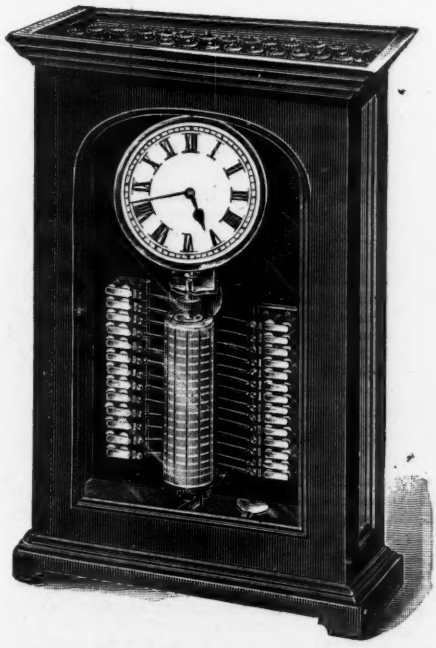
Mons. E. Ravet, of Clerkenwell, E.C., has issued an illustrated list of his improved lathe attachment or appliance for making screws. He supplies all kinds of electrical screws and terminal turned parts

Crompton's New Works.—A mishap occurred in the erection of Messrs. Crompton's new works at Chelmsford, on Sunday morning. Part of the outside walls of the main building has just been erected, and within the last week or so the contractors have put up a number of iron columns and girders inside the building, which were to be utilised for electrical travelling cranes, &c. During the severe storm on Sunday the wind brought the whole of the ironwork down with a crash, portions of the walls also giving way at the same time. The work of construction will be delayed only about a fortnight.

Dissolution of Partnership.—Messrs. L. W. Douthwaite & C. M. Stead, carrying on business as electrical engineers at 6, South Parade, Leeds, under the style of the Electrical and Mechanical Supply Company, have dissolved partnership by mutual consent, as from August 1st, 1896. Mr. Stead will attend to debts.

Dry Steam.—The Empire Company of Manchester has issued a list of its Stemtriff steam dryer and separator. These are specially adapted for high class steam engines, steam hammers, and water gas generators. The steam takes a spiral course, and the water separates itself from it by being "whirled" against the sides of the separator, whilst the steam is gradually collected from the centre in a dry state.

Electric Recorders.—We have before us an illustrated price list of patent watchman's clocks and electric tell-tales, as manufactured by Messrs. Gent & Co., of Leicester. Illustrations of various types of clocks, &c., shown, also particulars are furnished of



the many public and private buildings in which they are fitted. We illustrate above their improved dry ink marking tell-tale, which makes a clear and definite record in ink. The cylinder is 3 inches in diameter, and on it is fixed a paper record sheet with the hours of the day and the names of stations marked thereon. Underneath the cylinder and running parallel with its axis are the markers, the number of these, also the length of the cylinder depending upon how many stations it is desired to communicate from. Each marker is operated by an electro-magnet, so connected that when a comparatively weak current is sent through its coils, the marker jumps up and strikes at the record sheet on cylinder; between the markers and the cylinder is an ink ribbon, which is so fixed that every time a marker strikes, a clear indication is printed on the record sheet opposite the name of the station which controls the marker, and in the hour space corresponding with the time the movement is made. After each night's work the printed record is removed and a clean one put on. To make this change the cylinder is pulled forward and removed from the case, and in replacing it, by an automatic patented arrangement, a fresh surface of ink ribbon is given to each marker, thereby ensuring a distinct and clear printing for the next night's work.

Elmore's.—A holder of 333 shares in Elmore's Wire Manufacturing Company writes to the *Financial News*. He considers that the company's present unsatisfactory condition calls for some action on the part of the shareholders. He will be glad to hear from any shareholder who intends being present at the forthcoming meeting of the company (with a view to joint action), or from any others who may feel disposed to trust their interests in his hands.

Electric Tram Poles.—Mr. John Spencer, of Wednesbury, is now putting on the market his patent double grip joint. The principle of the joint is seen in the sketch. By its use lengths of parallel or taper tubes can be coupled up, the inner tube being hung upon the outer one, and all shrunk together, making a compact and rigid pole that resists the horizontal strain of overhead trolley lines in a most perfect manner. Poles can be built up on this principle of any height and of any diameter, and the system is particularly

applicable to tram and telegraph poles, arc light lamp-posts, &c. This system of making the joint does away with the risk of telescoping, which is so apt to take place with many descriptions of poles now used for trams. Mr. Spencer is now engaged upon some very large contracts for telegraph, tram, and arc light poles, also high pressure steam mains for electric light work, and he has some good orders for drawing in mains for electrical conductors in addition to being well occupied with the autumn demand for gas, steam and water tubes and fittings.

Fire.—The Guernsey Electric Railway Company's sheds at St. Sampson's northern terminus were destroyed by fire on Thursday night last week.

For Sale.—From our "Official Notices" in this issue will be obtained particulars of the businesses of Paterson & Cooper, which, as already announced, are offered for sale by private treaty by the trustee, Mr. E. C. Moore.

Gas.—A serious fire was caused by an escape of gas at the Coach and Horses, St. John's Square, Clerkenwell, on 9th inst.

On 4th inst. a serious gas explosion occurred at the Anerley Arms Hotel, Anerley. A portion of the house was wrecked.

Trying to find a gas leakage with a naked light caused a gas explosion the other day at Wellington Street, Aldershot.

Several people were injured by a gas explosion at Lisle Street, Newcastle, on 10th inst.

Much damage was done at Wellington Street, Aldershot, on the 2nd inst. by an explosion of gas.

Jandus Arc Lamps.—We are informed that the Jandus arc lamp is now entirely replacing the ordinary type at the Alhambra and Daly's Theatres. They are also in use at the Royal Court Theatre, Liverpool, and are being installed at the Argyle Theatre, Birkenhead, and many other places of amusement in the United Kingdom. Thirty of these lamps are in use at the Army and Navy Stores, and a large number at the Army and Navy Auxiliary Stores, and Harrod's Stores.

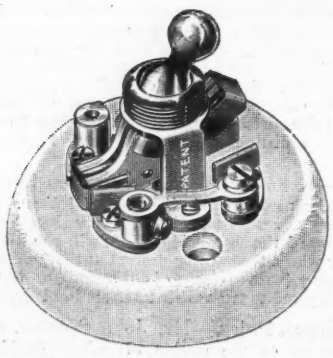
Liquidation Notices.—At a meeting held at 85, Queen Victoria Street, E.C., on 5th inst., it was resolved to wind up the Phonopore Company voluntarily, Mr. Charles Isaac being appointed liquidator.

Manchester Edison-Swan Company, Limited.—We hear that this company is exceptionally busy, indeed, that orders are too plentiful. New works are to be laid down at Broadheath, and 4 acres have been purchased there by the Company for that purpose.

New Business.—Messrs. Gent & Tomlyn have commenced business at Champion Electrical Works, Wellington, Somerset, as manufacturers of electric indicators, bells, &c., and electric light engineers. We understand that Mr. Gent is son of the head of Messrs. Gent & Co., Leicester, and Mr. Tomlyn was head of an old established local engineering firm.

Röntgen Rays.—From Messrs. A. Hurst & Co. we have received a capital list printed on excellent paper and nicely illustrated, showing their Röntgen ray outfits for radiography. Radiographs of the trunk and arm are given, also prices and particulars of induction coils, focus tubes and fluorescent screens. We refer in another column to an important performance conducted by Messrs. Hurst in Röntgen radiography.

New Two-way Switch.—Messrs. J. H. Tucker & Co., of Birmingham, have just placed a new two-way crank switch upon the market. The action is arranged upon their "crank" principle, by which an arrangement of leverage between the handle and



the contact arm is obtained, which gives at once a very smooth and easy movement. The contact arm is controlled from beneath by a powerful spring, which prevents it remaining in any position midway between the contacts. A large number of orders have been received.

ELECTRIC LIGHTING NOTES.

Ayr.—The Council has instructed Mr. Hammond to invite tenders for two engines and boilers, for extensions.

Barry.—The question of lighting several prominent business houses in the Barry district by means of electricity is under consideration. The new Windsor Hotel is already being fitted and wired.

Branksome.—The District Council has given its approval to the application of the Bournemouth and District Electric Supply Company for a provisional order, on certain conditions.

Bury.—On 5th inst. the Corporation electric lighting works were formally opened by the Mayoress (Mrs. J. Hall), who, in the presence of a large company, switched on the current. The centre of the town was, in the evening, illuminated by electricity. A banquet followed the ceremony.

Camberwell.—The stores premises of Messrs. Horsley and Sons, in Camberwell New Road, are now electrically lighted both inside and out. Two gas engines drive two 65-ampere dynamos, which supply current to 160 lamps.

Cheltenham.—The electric light has been partially installed at St. James's Church. The portions lighted are the north and south aisles and the vestry, 33 electric lamps taking the place of 42 gas jets. The supply of current to the St. James's Square subdistrict is made at a pressure of 200 volts. In addition to the church, Messrs. R. E. and C. Marshall, the contractors, connected up two of the large residences in the square.

Colwyn Bay.—The District Council has resolved to offer prizes of £30 and £20 for the best schemes for supplying electricity to the district.

College Lighting.—Messrs. Lord & Shand have obtained the order for lighting Shebbear College by electricity with 120 incandescent lamps, the current for which will be supplied by a Taunton dynamo and a storage battery of E.P.S. cells. The dynamo is driven by an oil engine.

Croydon.—Last Friday night the Mayor performed the ceremony of opening the new electric lighting station at Waddon. The Mayoress turned on the current.

Country House Lighting.—No less than 30 country mansions are at present being fitted up with electric lighting installations by Messrs. Drake & Gorham, amongst which may be mentioned: "Wolseley Hall," for Sir Charles Wolseley; "Castle Eden," for Mr. Rowland Burdon; "Kilmore," for Sir William Power; "Sotterley Hall," for Colonel St. John Barne; "Whitehall," for Mrs. Stock; "The Cliffe," for Mr. S. O. Hermon; "Swaylands," for Mr. George Drummond.

Devizes.—The Town Council has authorised the granting of a license to Messrs. Brown & May, Limited, to supply electric light to private consumers in the town.

Dundee.—The electricity rental for the five months ended September was £877 11s. 2d. compared with £904 3s. 4d. last year, a decrease of £29 12s. 2d.

Ealing.—The surveyor reports 9,160 private lamps connected, and 150 applied for.

Elland.—A proposal is to be made that the Council take into consideration the desirability of introducing electricity for lighting the district.

Glasgow.—The Liberal Club was, on 5th inst., lighted by electricity. The installation includes lights in the reading room, billiard room, smoking room, card room, vestibule, stairs and passages. Messrs. W. Ramsay & Co. were the contractors.

Grasmere.—A letter was recently received by the Council from the Board of Trade, stating that the Electric Light Company had applied for an extension of time in which to promote their scheme, and asking for the observations of the Council. The Council resolved that no objection be offered.

Halifax.—Councillor Thornton is to bring the electric lighting question before the District Council at the next meeting.

Halstead.—The Lighting Committee considers that, owing to the present financial position of the Council, it is desirable to postpone the question of electric lighting until May next.

Hampstead.—The Vestry last week resolved to light High Street, Heath Street, Rosslyn Hill, and Haverstock Hill by 28 arc lamps at a cost of £1,625.

London, E.C.—At the meeting of the Commissioners of Sewers on Tuesday, the recommendation of a committee "that a fee of 10s. should be fixed for the testing of consumers' wires and fittings under the provisions of the regulations made by the Board of Trade under the Electric Lighting Acts and Orders, and that notice of the intention of the Commissioners to prescribe such fee be duly advertised," was adopted.—Mr. Voysey, in answer to Mr. Barham, said the meters registering the current of the electric light were not always correct. The meters varied from 30 per cent. fast to more than 20 per cent. slow, but on the whole he believed the electric current was fairly registered. Indeed, the balance was in favour of the consumer.

Lincoln.—The City Council has completed arrangements for memorialising the Board of Trade for a provisional order. The estimated cost of the electric light undertaking is put at £17,000.

Manchester.—The new Lord Mayor gave, at the Council meeting on the 9th inst., a *resumé* of the work done, and said, among other things:—"In the electric lighting department the applications for supply continued to be numerous, and could scarcely be kept pace with, the present number of consumers being 1,302, to supply whom 138 miles of mains and services have been laid down. It was most satisfactory to find that although in many respects gas and electricity were rivals, they were here friendly rivals, under the control of the same committee, and the marked success of the new illuminant seemed but to have increased the success of the older, and to develop new purposes to which it might and could be applied."

Mile End.—The Vestry again discussed the electric lighting question last week, and resolved by a majority of one vote to oppose the application of the County of London and Brush Provincial Electric Lighting Company for a provisional order.

Montrose.—Mr. Young, Glasgow, has been appointed to superintend the alterations to the electric plant at Sunnyside Asylum.

Morley.—The Town Council has adopted a number of tenders for the various sections of the work connected with the electric lighting scheme for the borough.

Newmarket.—A public meeting has been held protesting against the action of the District Council in resolving to apply for an Electric Lighting Provisional Order.

Paisley.—The Council has agreed to acquire a site offered for an electric lighting station. Mr. Teague, electrical engineer, has been appointed to submit a sketch of a station capable of supplying 10,000 lights.

Pietermaritzburg.—The Lighting Committee of the Corporation have recommended the immediate adoption of a system of street lighting by electricity. The Corporation, after discussing the proposal, adjourned the matter for a fortnight.

Provisional Orders.—The *London Gazette* for November 10th contains notice of application to be made to the Board of Trade during the 1897 session by the following bodies for electric lighting provisional orders:—Denton Urban District Council, Epsom Sanitary Authority, Reigate Corporation, Hoylake and West Kirby District Council, Bury St. Edmund's Corporation, Brighouse Corporation, Watford District Council.

Redditch.—The Council is applying for a provisional order for lighting the town by electricity.

Shoreditch.—A proposal has been brought before the Vestry by the Electric Free Wiring Syndicate, who offer to fit up consumers' premises without any initial charge, the stipulation being made that the consumer so wired should pay ¾d. per unit more for the energy supplied to him than would be paid by a consumer who paid cash for his wiring, the vestry to pay the said ¾d. per unit to the syndicate. The vestry has approved of the scheme. The clerk is to draw up an agreement, which is to include a clause giving the vestry the option of purchasing at any time after three years, or any consumer after five, on terms to be settled in detail, the wiring to be done to the satisfaction of the vestry's engineers, and the contract not to be exclusive of other firms of free wirers. The vestry is to make application to the L.C.C. for a loan of £17,000 for electric lighting. The tender of Messrs. Atherton and Dolman (£893) for erecting a substation in Curtain Road has been accepted. The Bethnal Green Guardians have asked the Shoreditch Vestry upon what terms they will light the workhouse and the guardians' offices by electricity.

(*Continued on page* 636.)

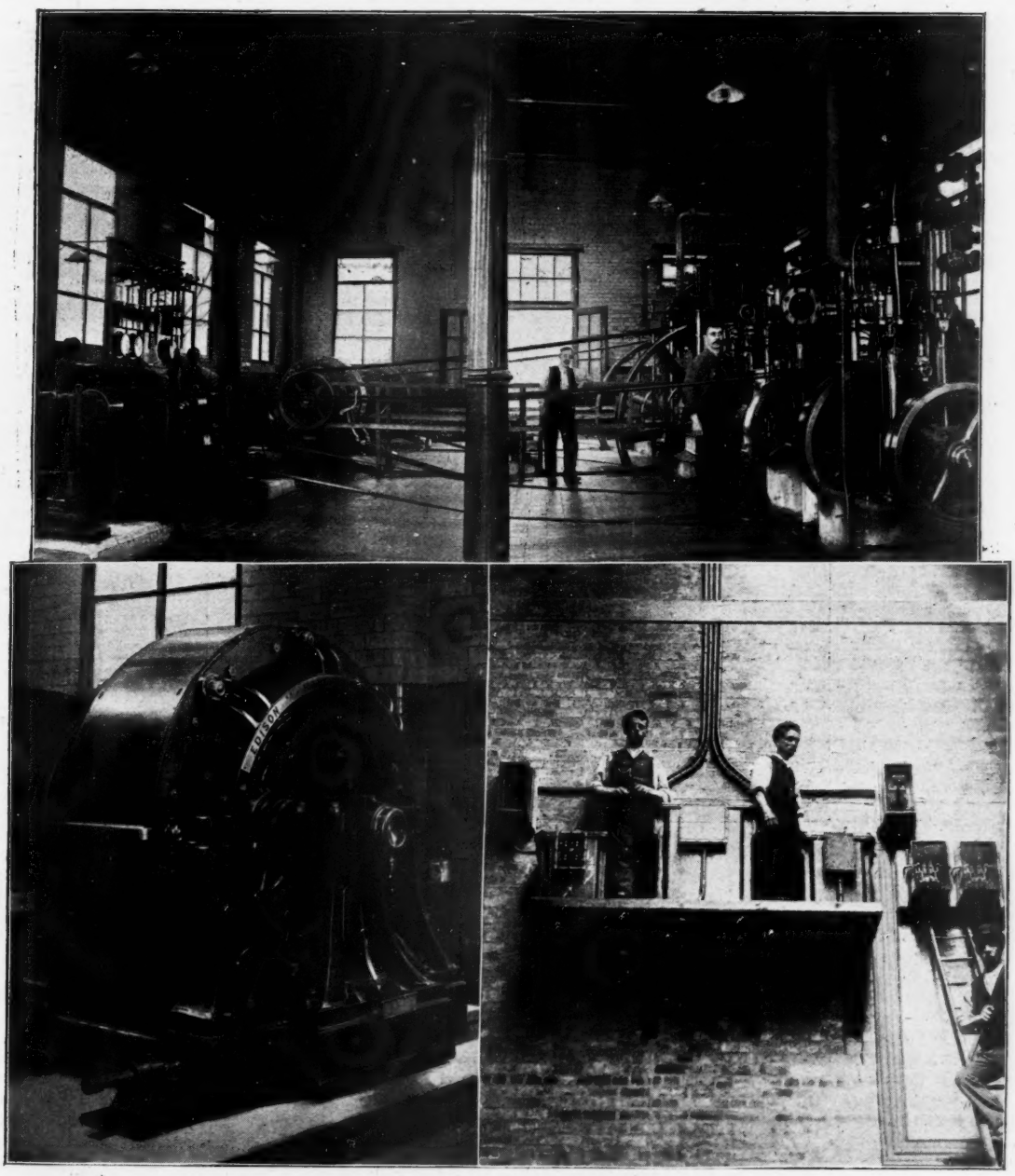
MANCHESTER SHIP CANAL ELECTRICITY WORKS.

Previous to the opening of the new works, the lighting of the Docks at the Manchester end had been of a purely temporary character, the power for which was generated at three different points, arc lamps being principally used both for indoor and outdoor lighting. Portable engines, which during the construction of the canal had been used for various purposes, were employed to drive the dynamos, and proving neither economical nor satisfactory, Mr. W. Henry Hunter, the chief engineer, about a year ago recommended the directors to lay down a permanent installation, and supply all power from one point. They ultimately consulted Mr. W. P. James Fawcus, M.I.C.E., and adopted his scheme, which has been efficiently carried out by Messrs. Baxendale & Co., with the result that the Docks are now very efficiently lighted, the transit sheds and warehouses being fitted up with 32 and 50 C.P. lamps, while the quay spaces and banks of the canal are illuminated by arc lamps.

The generating station is situated on the island near Trafford Road swing bridge, and is almost equidistant between the Pomona and the Salford Docks, which are the main points of supply. A wrought-iron supply tank, for feeding the jet condensers, has been fixed over one end of the building, and is supplied with water from the canal by means of centrifugal pumps. The dimensions of building are 55 feet 9 inches × 34 feet 6 inches.

The system of supply is high tension alternating current, working at 1,000 volts, which is transformed down to 100 volts for incandescent lighting and 525 volts for the two long series arc circuits. The cables forming the system of distribution are all concentric, with $\frac{1}{10}$-inch dielectric, having an insulation resistance of 2,000 megohms between inner and outer, and 1,000 megohms between outer and earth, and they vary in size from 37/14s. to 7/20s.

The cables were supplied by Messrs. W. T. Glover & Co., Salford. The chief feature of the installation is that the mains are carried overhead on poles, which stand 65 feet out of the ground, and spaced apart about 150 feet.



Lighting of Manchester Ship Canal.—Engines and Dynamos—Manchester Edison and Swan Alternator—Transformers Fixed on Platforms.

E

These poles consist of two lengths of pitch pine, scarfed and securely bound together by three iron collars; and the entire length tapers from 13 inches diameter at the foot to about 10 inches at the top. The poles are well tarred, and the butts charred for a length of 10 feet, to which depth they are sunk in the ground. In consequence of their height, the poles are very easily affected by any wind, which has necessitated the most careful staying. The cables are supported by galvanised steel bearer wires ranging in size from 19/16s. for the larger cables to 7/15s. for the smaller, to which they are attached by porcelain suspenders placed from 4 feet to 9 feet apart, and in addition are bound in at each pole to an oil insulator carried on a small bracket.

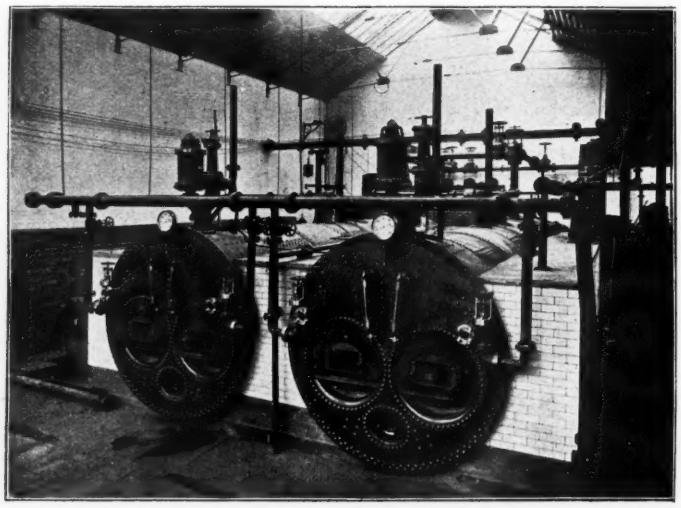
These bearer wires are shackled off and put to earth at every third pole, and in the case of the larger wires a swivel is inserted to regulate the strain, while the cables run right through to the tappings for the branch mains.

The various sheds and warehouses are illuminated by means of incandescent lamps of the "Manchester High Efficiency" type, of 32 C.P., on the floors of the brick warehouses, and of 50 C.P. in the single storey sheds.

In most cases one transformer feeds two sheds, the secondary mains for the shed on the other side of the pier being carried overhead across the roadway, while a main switch for each shed is placed alongside the transformer. They are supported on platforms which either stand out from the wall on iron brackets, or are suspended between the iron roof principals of the sheds.

These transformers are of the Manchester Edison-Swan Company's well known make, and are of the closed magnetic circuit type, the iron core being composed of thin sheets of iron stamped to shape, and held together in a suitable clamping frame.

They are enclosed in cast-iron cases thoroughly watertight, and are provided with suitable stuffing boxes and glands for the introduction of the cables.



Boiler House at Bury.

They are fitted with lightning arresters on either pole, while the primary fuses are enclosed in a small cast-iron box, attached to one side of the larger case, so that they can readily and safely be removed by the attendant without the trouble of raising the cover. Earth shields are fixed between the primary and secondary coils, and the outer case is efficiently earthed.

In the three and four storey brick warehouses, the lights are arranged in rows of two and three, controlled by separate switches for each row, fixed on the opposite wall or adjoining column; while on the ground floor in each case there is erected a main switchboard upon which are mounted double-pole switches and fuses controlling each floor. These are enclosed in solid teak wood cases, and are only accessible to the attendant.

In the covered way, between each pair of warehouses, are suspended two Royce alternate current arc lamps arranged in series across the 100-volt mains, with an impedance coil in circuit.

The single storey iron sheds are provided with lamps of 50 C.P., arranged in two rows and controlled in sets of four by branch switches fixed on distribution boards at each end of the sheds.

The cables and wires are carried on porcelain insulators supported on iron brackets attached to the girder work, and the weight of the lamp fittings is taken up by iron strips, which prevent them from swaying about in the wind.

To light the quays, roads and railways, arc lamps are employed, arranged on two systems, one of which comprises 66 continuous current 10-ampere "Royce" lamps in circuits of four in series across 200 volt mains. These lamps are divided into two groups, one being switched off at midnight, thus necessitating the running of one plant only after that time.

The more important lamps are connected on the all-night circuit, and all lamps are so arranged that adjacent ones are on different circuits, while their average distance apart is 200 ft.

The lamps which light the quays are in the case of the single storey sheds suspended under the eaves to safeguard them from damage by the cranes, except at the ends of the piers where they are fixed on short wooden poles, which stand above the roof at the corners of the sheds, thus lighting up both the loading spaces and the approach to each Dock.

On the three and four storey warehouses the lamps are fixed by brackets to the wall at a height of about 25 feet, and are fitted with a concentric plug arrangement which allows the lamp to be lowered by means of a winch without having any spare cables hanging about.

The leads are brought to terminals within the socket, while the two halves of the plug are connected with the lamp, so that when raised into position the circuit is closed.

To serve the road and railways the lamps are attached to the poles carrying the cables at a height of 30 feet and 300 feet apart. The mains—three in number, the middle one serving as a common return when both machines are running — consist of hard drawn copper wires reducing in size from Nos. 2 to 6 gauge, while the circuit wires are of No. 8 gauge, except in the shorter runs, where No. 11s. are employed. These wires are carried on the same poles and standards as the high tension cables, being insulated by white porcelain insulators of the Post Office and shackle types.

At spots central to four or more circuits, wooden cabins are placed, which contain the necessary resistances, fuses and switches, to control the branch circuits.

The other system is an alternating current one, having 28 12-ampere Crompton-Pochin lamps arranged in two long series of 14 lamps on each. These lamps light the portion of the Docks most remote from the engine room, also the Mode Wheel Locks, a mile and a half away, and are so arranged that adjacent lamps are on different circuits. A 7/14s. concentric cable is brought from the engine room to a warehouse near the initial point of supply, and is there branched to feed two transformers, which convert the pressure from 1,000 volts to 525 volts to serve these circuits. From the secondary of each of these is run a 7/13 concentric cable on to the outer of which are joined the 14 lamps.

Each circuit is provided with a high tension switch and an impedance coil, which chokes 200 volts with the core right in.

The single length of concentric cable in each circuit amounts to about 2,300 yards, in which there is a loss of 30 volts. Where the cables are laid under the canal they are lead-covered, and possess an insulation resistance of 5,000 megohms per mile.

The electrical plant consists of two alternators with independent exciters, and two arc light dynamos. Each alternator is capable of an output of 60 amperes at 1,000 volts, working at a frequency of 83 periods per second, and is driven by a vertical compound condensing engine of 100 B.H.P., by Messrs. Goodfellow, of Hyde.

These machines were manufactured by the Manchester Edison-Swan Company. They have stationary armatures with revolving fields, the field magnet being a special feature of the machine, consisting of one solid steel casting, with the exciting coils so wound that centrifugal force does not tend to displace them, the result being a strong mechanical arrangement. The armature has an iron core, and the coils are wound in tunnels insulated with ebonite tubes.

The ends of the coils are completely closed in, with the exception of the perforations for ventilation, in order to prrotect them from dust.

The bearings are fitted with brasses, lined with magnolia metal, and are exceptionally long.

The side frame is of massive construction, and divided into two parts, so arranged that the upper half of the armature can be easily removed for inspection. They are rope driven, and run at 600 revolutions per minute.

Each exciter has an output of 18 amperes at 100 volts, and runs at about 1,550 revolutions per minute.

These machines are compound wound, with armatures of the Gramme ring type; they are belt driven from a pulley on the engine shaft.

The dynamos which provide power for the continuous current arc lamps are of Messrs. Royce & Co.'s make, and are compound wound machines with drum armatures, having an output of 90 amperes each at 220 volts, and run at 1,100 revolutions per minute. These also are belt driven by independent vertical compound engines of 30 B.H.P., by Messrs. Browett & Lindley, of Patricroft.

There are two switchboards, one for the alternating and another for the direct current system.

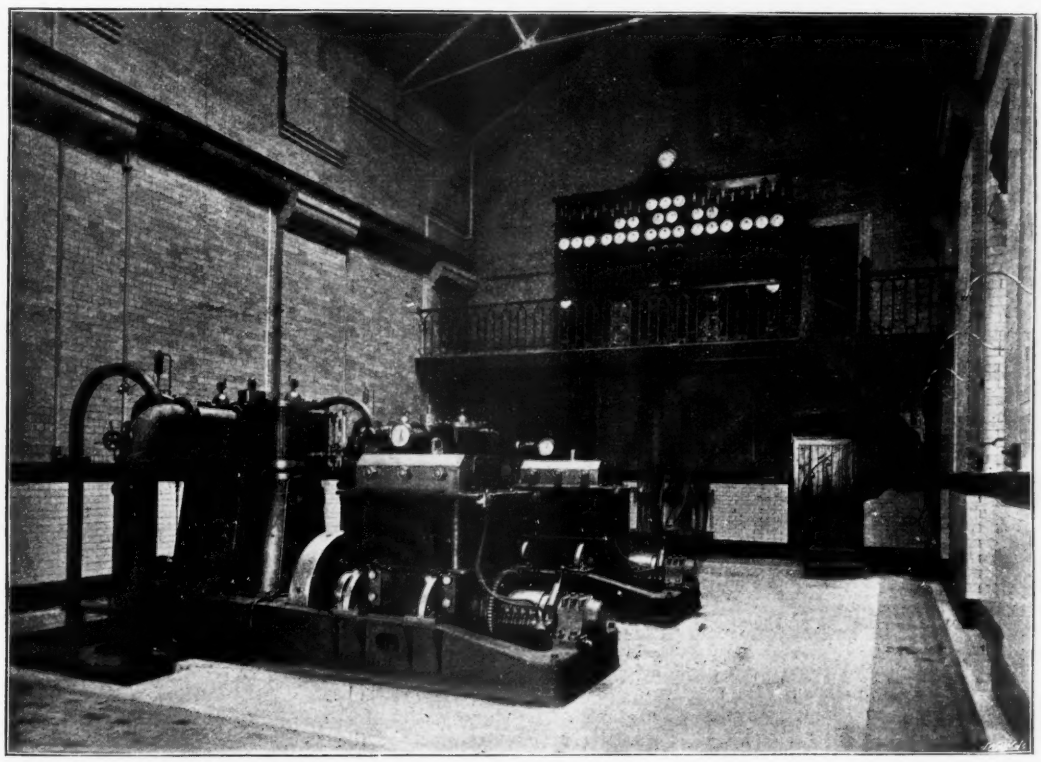
The former consist of two slabs of enamelled slate, in a teak frame, upon one of which are mounted two ammeters, reading up to 75 amperes, two double pole alternator switches having laminated copper contacts, which protrude above the slate, but are well out of reach at the top of the board—the switches being controlled by long ebonite handles—also two double pole fusible cut-outs.

The other slab is fitted with two electrostatic voltmeters with a range from 600 to 1,250 volts, two main circuit switches and one coupler switch, two main fuses, and four single pole lightning arresters. On the wooden panels forming the framework of the board are mounted two 20-stop segment switches to adjust the resistances for the alternator fields.

In addition to these, synchronising transformers with lamps and switches are being provided for paralleling purposes.

The switchboard for the arc light circuits also consists of two slate panels, in a wooden frame, upon each of which are mounted two ammeter voltmeters, two double pole switches and fuses, segment switches for the shunt resistances and lightning arresters, one set for each machine.

As we have already mentioned, the contractors for the whole of the electrical work were Messrs. Baxendale & Co., Miller Street, Manchester—their foreman on the ground being Mr. George Rogan—who successfully carried it out under the direct supervision of Mr. D. O. Evans, the clerk of works representing the Manchester Ship Canal Company.



Engine and Dynamo Room at Bury.

BURY ELECTRICITY SUPPLY WORKS.

In the year 1890, the Lancashire and Cheshire House-to-House Supply Company applied for the sanction of the Corporation to an application to the Board of Trade for power to supply electricity within the borough. This the Corporation refused, and towards the close of the following year (1891) a committee was formed to inquire and report as to the desirability of the Corporation themselves taking up the matter.

This committee, in conjunction with Mr. Joshua Cartwright, M.Inst.C.E., the borough engineer, visited a few central stations in various parts of the country, and also consulted Dr. John Hopkinson, F.R.S., and finally reported to the Council "that it would be to the interests of the borough to keep the control of the supply in the hands of the Corporation." Whereupon the Council appointed an Electric Lighting Committee with full power to consider the whole question, and recommend a scheme for adoption.

In their investigations, however, the committee found such a variety of opinion existing, that they did not feel justified in recommending the adoption of any system, and they

instructed the borough engineer to prepare "conditions" on which manufacturers should be invited to supply competitive schemes, adopting such systems of supply and types of motive power as they considered best suited to the particular requirements of the borough. This was done, but none of the tenders met with the entire approval of the committee; the information gained, however, led them to conclude that a "low tension continuous system" was the most suitable, and the borough engineer was instructed to prepare a specification.

Mr. Cartwright, however, advised that expert advice should be called in for the electrical work, and Mr. Wynne was appointed Borough Electrical Engineer. Specifications were issued and tenders received in 1894, but nothing further was done until 1895, when revised specifications were issued. In the meantime, Mr. Wynne had resigned his position, and Mr. E. M. Lacey, A.M.I.C.E., was appointed consulting engineer, to advise generally on all matters until completion of the scheme.

The committee further instructed that the borough engineer prepare a specification and drawings for the station buildings, and that tenders should be obtained for their erection. This was done, and the tender of Messrs. Storrs, Sons and Co., of Stalybridge, was accepted and the work proceeded with.

After careful consideration of the tenders, the committee, under the advice of the consulting engineer, recommended the acceptance of the tender of Messrs. Siemens Brothers & Co., Limited, of London, and to that firm was entrusted the supply of the whole of the plant required to equip the station.

Accumulator House at Bury.

Three sites, all in the possession of the Corporation, presented themselves to the committee as suitable for the central station—the Fairground—Fernhill Yard — the Crappers, Rochdale Road. The latter was found to offer the most advantages, bearing in mind present and future requirements.

The station buildings occupy an area of 10,000 square feet, but there is sufficient land left to more than double the present accommodation, as well as to provide reservoir space for condensing purposes, the water for which can be obtained from Barnbrook, which runs along the whole length of the easterly side of the site.

These are of a substantial character—brickwork with stone dressings—and consist of offices, store rooms, workshops, accumulator house, boiler house, engine and dynamo house.

The present entrance is from Back Derby Street, but the design is so arranged that ultimately the principal entrance to the offices will front Rochdale Road. On the right of the main entrance is a staircase leading to the engineer's office, testing and store rooms on the first floor. On the left is the inquiry and weigh office. Proceeding along the corridor and crossing the cart entrance is the repair workshop, with a floor area of 840 feet paved with wood blocks. Passing through the workshop and entering a lobby to the right is the accumulator house containing a floor space of some 1,550 square feet. The walls are lined with salt glazed bricks throughout. The floor is paved with Staffordshire chequered blue bricks on a bed of 6-inch cement concrete, pillars of salt glazed bricks are built to form benches to support the cells. The lighting is from the windows along the south wall; a continuous open ventilator runs along the whole ridge of the roof, which is of deal, painted with Griffith's enamel to preserve it from the acid fumes arising from the cells.

Returning by the lobby, the engine and dynamo room is gained. This room is of fine proportions, 60 feet × 30 feet wide, and 36 feet high to the ridge of the roof. The walls to dado height are of glazed bricks in colours of brown and cream, the space above dado is of Aston Hall buff bricks. The whole of the steam, exhaust and water mains, together with the cables, are laid in brick conduits below the surface of the engine room floor, the conduits are covered with gratings of a neat pattern let into stone curbs. The floor is paved with encaustic tiles with pattern border. The roof is of iron, boarded with 1½-inch boards on the angle, upon the boards is a layer of felt, the whole being covered with Vellenhelli slates. The lighting is effected by windows of fair proportions along the westerly side, and by a lantern light from the roof which also forms a ventilator, fitted with Wragge's patent opening gear. Moulded stone corbels, 20 feet from the ground level, run the whole length of the east and west walls to support the rails for the travelling crane. The engine room is large enough to hold double the present plant, whilst provision has been made for easily extending it to double or treble the present length should it be required.

At the south end of the engine room is erected a gallery to carry the switchboard. The front of the gallery is protected by an ornamental iron railing, topped with polished moulded hand-rail. The gallery is approached from the engine room by an ornamental circular iron staircase, and also by the corridor of the first floor from the engineer's office.

Passing through a door at the south-east of the engine room is the boiler house, which is 60 feet × 60 feet × 20 feet high from the boiler house floor, The roof is of iron, in two spans, supported by girders and columns, with louvre ventilators its whole length. Light is obtained by skylights the whole length of the roof. There are three large doorways, fitted with patent revolving steel shutters, through which the coals may be tipped into the stoke-holes.

The chimney shaft, which is of brick, rises through the roof of the boiler house, and is 14 feet square for a height of 48 feet from the boiler-house floor; the remaining portion is octagonal, and surmounted by a terra cotta top; it is lined inside with firebricks for a height of 60 feet, the total height of the chimney being 150 feet.

The present plant consists of two Lancashire boilers, each 30 feet long × 7 feet internal diameter, with two flues. They were made by Mr. William Lord, of Bury, to fulfil the requirements of the Manchester Steam Users' Association. The whole of the fittings and mountings are of Messrs. Hopkinson's make, and include, with the usual safety valves, &c., two check feed valves to each boiler and duplicate feed pipes. Each boiler is set 1½-inch lower at the firing end than at the opposite end. Cass's patent firebars have been adopted. The boilers were tested hydraulically at the maker's works to a pressure of 250 lbs. per square inch, and a similar test has been applied since erection. The working pressure is 140 lbs. per square inch. Space is provided for a third boiler.

The main steam pipe is 6 inches internal diameter, and of lap welded mild steel, with wrought-iron flanges screwed and brazed to the pipes. All bends are of solid drawn copper with wrought-iron flanges. The pipes are alternately turned with a recess and projection, and washers of woodite are inserted in recess to make the joints. All pipes in the engine room are placed in trenches below the ground floor level, the spindles of all valves being lengthened to project above the floor plates. The whole of the valves are of Messrs. Hopkinson's make, those above 2½ inches diameter

being of cast-iron, with gun-metal working parts, and those below 2½ inches entirely of gun-metal. The exhaust pipes are of cast-iron, treated whilst hot with Angus Smith's compound, the faces of all flanges being machine-faced and jointed with woodite. All the steam pipes are covered with non-conducting composition. Two steam traps of the type made by McDougall are used for draining the steam-pipes.

Provision is made either to exhaust direct into the atmosphere or into a "jet" condenser made by Messrs. Worthington. The condenser is capable of condensing 14,750 lbs. of steam per hour.

Three tanks have been supplied; each is built up of ⅜-inch cast-iron plates, machine-faced and bolted together. The one for storage of cold water from town's supply is 18 feet long, 12 feet wide, and 6 feet deep, and is erected 15 feet above the boiler house floor, and supported by iron joists resting on cast-iron pillars. The one for hot well is 15 feet × 6 feet × 4 feet, and is to receive the discharge from the condenser pump; it is provided with a large overflow pipe for delivery back to the cooling reservoir. The one for cold water tank is 12 feet × 6 feet × 6 feet, is fixed 1 foot above the boiler house floor; it is connected with cast-iron pipes, 8-inch diameter, to the cooling reservoir. The condenser pump draws from this tank.

There are two pumps of the Worthington make, having dimensions 4½ × 2¾ × 4. These are fixed to stone beds at the sides of the boilers, and are capable of acting either singly or together to take water either from the town's water tank or the hot well, and feed into duplicate pipes either through the economisers or direct into the boilers.

The economiser has been supplied by Messrs. Green, and is erected in the main boiler flue, suitable bye-pass with dampers being fixed to enable it to be cut out for inspection or repairs. There are 120 pipes in rows of six each; stop valves are fitted to the water inlet and outlet, and also to the blow-off. A safety valve, set to blow off at 160 lbs., is also fixed. The scrapers are worked by means of a Siemens's 1 horse-power motor, taking current at 220 volts.

The engines consist of four of Messrs. Belliss's enclosed double-acting compound condensing type, fitted with patent forced lubrication. The two small engines work up to 38 I.H.P., and run at 500 revolutions per minute. The two larger ones give 240 I.H.P., and run at 350 revolutions per minute. They are fitted with indicating gear, steam separator, and sight-feed lubricators. Special attention has been given to the governing of these engines, the tests taken showing them to be very satisfactory.

Each engine is mounted on a cast-iron bedplate, with its respective dynamo, being coupled direct by means of a flanged coupling. The dynamos are of Messrs. Siemens's well known two-pole type, shunt wound for continuous currents, with drum armatures. The bearings are fitted with rings which run upon the shaft and dip into an oil bath contained in the pedestal, thus ensuring continuous lubrication. An oil gauge fitted to each bearing indicates the amount of oil contained in the pedestal. The small dynamos have an output when charging of 145 amperes at 160 volts, and are capable of giving 200 amperes at 110 volts when running direct on to the bus bars. The larger dynamos have an output of 500 amperes at 260 volts. At full load they all run absolutely sparkless. The efficiency of the small combined sets $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ is 82·3 per cent., and for the larger sets 86 per cent.

An overhead travelling crane, by Messrs. Carrick and Ritchie, of Edinburgh, traverses the whole length of the engine room on steel rails bolted to steel joists. It is erected 20 feet above the floor level, has a span of 30 feet, and will lift a dead weight of 10 tons. The cross beams are of rolled steel, bolted to cast-iron end pieces and running on double flanged wheels; all motions being worked by hand.

The cells, 130 in number, are of the Electrical Power Storage Company's K 58 type, in lead boxes. They are arranged in sets of 64 each, leaving two spare cells to be used as "milkers," for testing or other purposes. The guaranteed output of each cell is 360 amperes for two hours' continuous run. Connections to switchboard are made by means of bare copper rods carried on porcelain insulators and run through the wall to main switchboard in special insulating tubes. All the copper rods are coated with anti-sulphuric enamel.

The switchboard is mounted on a gallery at the south end of the engine-room. The slabs are of enamelled slate, and are mounted in polished wood frames, the mouldings being struck from the solid. The board has been designed to control six dynamos (four large and two small), and a battery of accumulators, to work in parallel, and also six feeder circuits. Instruments and switches are provided for four dynamos, but spaces are left to receive those for two others. At the top of the central panel is fixed an eight days' striking clock. Each machine is provided with an automatic cut-out, fuse, shunt break switch (locking with cut-out), shunt regulating switches, ammeter and voltmeter. The battery charge and discharge switches are mounted on the middle panel, as are also the switches, fuses, and ammeters. There are also two reversible ampere hour meters of the Aron type, fitted with Miller's patent compensation arrangement for charge and discharge. Each feeder is provided with duplex fuse and ammeter, also Thomson-Houston recording wattmeter. All the instruments are of Messrs. Siemens own make. All joints and connections are at the back of the board, where space has been left to enable any work to be easily carried out.

The cables are of Messrs. Siemens's manufacture, insulated with vulcanised rubber. They are drawn into 4-inch cast-iron spigot and socket pipes with lead joints. Two feeders, each 700 yards run, have been laid, the outside cables being ·77 sq. in. with a guaranteed insulation resistance of 2,600 megohms per mile, the middle wire is ·24 sq. in. Pilot wires are run from feeder points to the switchboard; they consist of four valcanised cables of 7/20's S.W.G., each cable of different colour, and the four braided together to form complete cable, the whole being extra taped and coated with preservative compound. The fourth wire is for testing purposes. Each of the distributing cables is covered with distinguishing coloured tape. The outside cables of distributors are of ·15 sq. in. section, the middle being 19/16's, all having insulation resistance of 3,000 megohms. The whole of the joints are made with gun metal sleeves, soldered solid and vulcanised over all. Boxes are placed every 50 yards to facilitate the drawing in of cables, whilst small inspection boxes are built outside every two or three houses to enable consumers to be connected.

There are 45 incandescent lamps, and four 10-ampere arc lamps of the Crompton-Pochin type, used in lighting the works and offices. The lighting of the engine room is by means of lamps carried on polished brass brackets fixed about 8 feet high, one arc lamp is also suspended from the centre of the roof. The stoke-hole is lighted by one 10-ampere arc lamp and a few incandescent over gauges. At the entrance to the yard there is an arc lamp fixed on an ornamental bracket, and one is also fixed near the boiler house doors to facilitate the unloading of coal, &c. The offices have for the most part ordinary drop lights where required. The whole of the wiring of the building has been carried out by Mr. S. H. Heywood, of Manchester.

The contractors for the machinery and plant were Messrs. Siemens Brothers, London, who have employed as subcontractors:—Engines: Messrs. Belliss & Co., Birmingham. Boilers: Mr. William Lord, Bury. Economiser: Messrs. Green, Wakefield. Steam and water piping, tanks, &c.: Messrs. Abbot & Co., Limited, Gateshead-on-Tyne. Steam pumps and condenser: Messrs. Worthington Pumping Engine Company. Steam and other valves: Messrs. J. Hopkinson and Co., Huddersfield. Water valves and meters: Messrs. the Glenfield Company, Kilmarnock.

Mr. C. J. Batley, of the borough engineer's department, has acted as clerk of works for the erection of the machinery, and Mr. Geo. E. Smirke for the construction of the buildings.

The whole of the work has been carried out under the personal supervision of the borough engineer, Mr. J. Cartwright, M.Inst.C.E., and the borough electrical engineer is Mr. S. J. Watson. Mr. W. H. Vincent, representing Messrs. Siemens Bros., it should be mentioned, was in charge of the erection.

The Electricity Committee consists of Aldermen Charles Brierley, Alfred Hopkinson, John Parks; Councillors John Ashworth (chairman), J. K. Butcher, James Byrom, T. S. Collinge, J. W. Kay, Thomas Mellor, J. H. Pickup; and Mr. John Haslam, the Town Clerk.

ELECTRIC LIGHTING NOTES.

(*Continued from page* 630.)

Southport.—Acting upon the report of the electrical engineer (Mr. C. D. Taite) that the limit of supply will be reached in March next, the Electricity Committee recommend that application be made for a £12,000 loan for extensions.

St. Helen's.—The Gamble Institute is lighted by 800 16-C.P. lamps, current being taken from the Corporation mains. Messrs. Bennett & Druce executed the work under the supervision of Mr. E. M. Lacey.

Stroud.—Messrs. Marling & Co., Limited, have recently had a very complete electric light installation put down at their Ebley Mills, Stroud. A 35-H.P. vertical high speed engine drives a Tyne dynamo (175 amperes) by means of belt. Throughout the mill there have been fixed 350 lights attached to brackets and flexible pendants. The work has been carried out by Messrs. Ernest Scott and Mountain, Limited.

Torquay.—The Corporation has postponed consideration of the electric light tenders until to-day.

Wallasey.—The applications for current are so numerous, that the question of extensions is mentioned.

Walton.—The Walton-on-Thames Electric Lighting and Power Company, Limited, has given the Council notice of its intention to proceed with an application for a provisional order in the ensuing session of Parliament.

Wells.—Dr. Hopkinson's report and plans for the lighting of the city with electricity are referred to the Lighting Committee, who will report to the December meeting.

Wimbledon.—The District Council has decided to apply for a provisional order for lighting the district with electricity.

Wolverhampton.—The Lighting Committee reports that the supply of electrical energy from the municipal generating station for purposes of illumination is increasing, and has risen from 7,936 8-candle power lamps in October, 1895, to 9,563 in September last. In the supply of units of electricity to private consumers there has been an increase of 55 per cent., comparing the Michaelmas quarters of 1895 and 1896. The new General Post Office, in Lichfield Street, is to be supplied with the electric light, and this establishment will become the largest customer the Corporation has.

Worsley.—The District Council has decided to take no action in the matter of supplying electric light in the district.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Blackburn Tramways.—We understand that the Local Tramway Company has practically agreed with the Blackburn Corporation to purchase electric current from the Corporation electric sub-station for working the tramways. The price to be charged per unit is 2¼d., measured at the generating station, the Corporation providing the feeders and the overhead lines.

Bridlington—Flamborough.—There is a project on foot for an electric or light railway to Flamborough.

Bristol.—A Bristol contemporary says that "The Sanitary and Electrical Committee were appointed a committee to report as to the desirability of introducing the overhead trolley system of electric traction on tramways."

Cardiff and Penarth.—It is stated by the *Western Mail* that Parliamentary sanction will be sought next session for the construction of an electric tramway between Cardiff and Penarth, and the lighting of the latter town by electricity, under the powers of a provisional order. It is stated that the owners of the road (the trustees of the Marquess of Bute and of Lord Windsor) are favourable to the scheme, which will probably include the transfer of the road to the local authorities. It is intended to widen the road where the highway passes under the archway at Llandough and to reduce the gradient considerably on both sides. At Cardiff, the electric tramway will have two branches, one terminating in St. Mary Street and the other near the James Street Bridge at the Docks. It is intended to run cars every 10 minutes, and there can be no doubt that the service, as well as being greatly appreciated, will be remunerative to the promoters.

Dublin.—*Freeman's Journal* believes that the "£270,000 required for the purchase money of the Southern District Tramway line, extending from Haddington Road to Dalkey, has been more than subscribed without any outside appeal to the investing public. So far, the financial return from the line has fully realised the expectations of the Dublin United Tramways Company."

Dublin and Kingstown Railway.—It is stated that the Dublin, Wicklow, and Wexford Railway Company intend promoting a Bill in Parliament for the purpose of obtaining power to use electricity as a means of traction on t Dublin and Kingstown line.

Hastings.—A memorial to the Mayor and Corporation of Hastings is being extensively signed by residents on the Front Line in favour of a tramway by electric or other traction, owing to the noise and vibration of the omnibuses at present being a great cause of complaint amongst visitors. Mr. Chadwell, C.E., of Richmond Chambers, Blackburn, orginates the scheme, and a contemporary says that the money will be ready as soon as sanction may be received from the Council.

Mont Blanc.—We learn that an electric railway for passengers is proposed for Mont Blanc. Up to a certain altitude it would be upon an inclined plane, and the ascent would be completed by a vertical shaft of a depth of 2,539 metres, through which powerful electrical lifts would convey the passengers to the observatory on the summit. The cost of an ascent under present conditions is 400f. for every person, and not more than 70 out of every 50,000 who annually visit the valley go up. By the new means of ascent, however, says a financial contemporary, the charge will be 150f., and the time occupied a few hours only. The outlay for the work is estimated at 8,000,000f.

Mumbles.—A second offer on behalf of an electrical syndicate has just been made for the purchase of the Swansea and Mumbles Railway, but the company has decided to refuse it, the offer for the goodwill not being regarded as sufficient. The negotiations, however, are expected to be resumed.

Municipalisation of Tramways.—On the 9th inst., the Manchester City Council had under consideration the municipalisation of tramways, and it was proposed that the special committee *re* working, &c., of tramways should consist of 15 members, and also the members of the Paving, Sewering, and Highways Committee. Alderman Milling, chairman of the Paving Committee, said it was altogether too large a special committee to propose, for the Paving Committee had some 24 members itself. Mr. J. W. Southern held that the subject was one of great importance, and requiring a large committee. Mr. Vaudrey and Mr. Royse also spoke of the importance of the subject, and eventually the proposal was adopted. The purchase of the tramways by the Council would probably tend in the direction of electric traction for that city.

Stretford—Peel.—The Ashton-upon-Mersey and Sale District Councils intend taking the feeling of the ratepayers regarding this proposed electric tramway scheme.

The Third Rail for the Nantasket Railway.—Many months ago we described in detail the use of the overhead trolley for the Nantasket Beach Railway. Since then we have recorded the fact that trials were being made of the third rail system. It has answered so well after a four months' trial, that the company which has been employing the method has decided to make greater extensions of its electric service. It ought to be again pointed out that this line deals with an enormous suburban traffic.

Yarmouth.—The Town Council on Tuesday had a lengthy discussion on electric traction, and we understand that the principle of electric tramways for the borough was agreed to, and the Lands Committee deputed to settle details so that the promoters may apply for a provisional order.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Monte Alegre-Santarem ...	May 5th, 1896 ...	...
Repaired as far as Parintins	... ...	Nov. 6th.
Para-Maranham	Oct. 8th, 1896 ...	...
Landlines.		
Trans-Continental line beyond Mazol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Khabarowska-Vladivostock	Nov. 7th, 1896. ...	Nov. 8th, 1896.

A Sore Point.—Speaking of the pending trial between the United States and Hayti Cable and Telegraph Company and the Compagnie Française des Cables Télégraphiques, *Le Soleil* fears that all submarine commnnications of the world being in English hands may prove a source of considerable power to England in case of war. For this reason all attempts made by French enterprise to battle against this English "ring" ought, our contemporary thinks, to be encouraged and supported.

The Pacific Cable Conference.—The conference of representatives of Great Britain and the Colonies on the subject of the proposed trans-Pacific cable between Australia and Canada resumed its sittings at the Colonial Office on Monday afternoon and yesterday (Thursday) morning, under the chairmanship of the Earl of Selborne. The delegates include Sir Mackenzie Bowell, Sir Donald Smith, and Mr. A. G. Jones, of Halifax, representing Canada, and Sir Saul Samuel and Mr. Duncan Gillies, representing Australia.

Ceylon Telegraphs.—An exchange states that Mr. D. Montague, who has been appointed Assistant Superintendent of Telegraphs in Ceylon, has arrived in the Colony and assumed his duties. Mr. Montague is stated to have been connected with the telegraphic department in Edinburgh.

Exports of Telegraph Wire, &c.—There was a much brisker state of affairs during October in the export trade of this country in telegraph wire and apparatus connected therewith, the value of the exports during the month being returned at no less than £162.054 as against £76,273 in the preceding month and only £39,769 in October last year. Although there is now no probability of the years' total reaching that recorded in 1894, yet it will show a satisfactory increase over last year, the aggregate exports during the 10 months ending with October having amounted to £699,905, as compared with £423,206 in the corresponding period of last year, and £1,326,855 in the first 10 months of 1894.

Telephone Grievances.—Telephonic grumbles are being revived in the *Daily Telegraph*, and the following gives the gist of the most serious complaints:—"From our own experience in several countries abroad, we are inclined to think the allegation that London has the poorest service of any other city is quite true, and it seems a pity that this scandalous state of affairs should not be remedied. This afternoon we waited for three-quarters of an hour to be connected with Glasgow, and when we were put through our communication was so indistinct that it was useless trying to do business with our clients in the North."

"I myself had a similar experience last Saturday. I wished to telephone to a Liverpool client on an important matter, and waited over half an hour to be connected. After the connection was made, neither my client nor myself could hear a word, owing to a bad hum on the wire. It afterwards transpired that we were both waiting at our telephones at the same time, so the delay in connecting was through no fault of ours."

A second subscriber says:—"On Friday night last, after repeatedly ringing without obtaining any response, I despatched a messenger with a letter to the head office in Gerrard Street, requesting an explanation. My letter was not even acknowledged. On Saturday my 'ringing appeals' still remained unanswered, and another messenger was despatched, to whom a verbal reply was vouchsafed to the effect that a man should be sent at once to inspect my telephone, and, if possible, find out and rectify the hitch. I need hardly say that nobody came, and the telephone remains dumb."

Another says: "Hardly a week passes in which we have not to complain about disturbances on the wire, and sometimes the connection is interrupted for a number of days. About two days after our complaint is made, a man walks into our private office, with his hat on, interrupting our work, taps the instrument, looks at the battery, and walks off, saying that it will be "seen to," and so it remains. The last experience of this kind took place about a week ago, but the disturbance continues."

The other side of the case is as follows: "We have a line connected with the general system in the Eastern District which was anything but perfect before being fitted on the improved system, and a change made from male to female operators at the exchange. Like others, we have complained for years, but since these alterations have taken place we think we are getting much better attention and a line that can be used. The telephone is a great tax on the nerves, and one minute in front of a piece of wood and metal waiting for a reply seems a much longer period, and we think one is apt to remember a failure a much longer time than all the other occasions when a reply is quickly obtained. If the English companies had the same assistance from the State as on the Continent, we should, no doubt, have a better service and pay less for it."

A representative of the *Daily Telegraph* interviewed the Post Office officials and the National Telephone Company, and the result of the inquiry, is that both the Government officials and the Telephone Company admit that communication with Glasgow and other northern cities is defective, but neither could quite explain the cause, or suggest a remedy beyond that of substituting metallic circuits and new transmitters at an increased cost of £2 per annum to the users of the telephone. The National Telephone Company, according to the representative consider that the local service in London is not open to much complaint, and further if the local authorities would permit the company to put their wires underground there would be a great improvement in the service.

Telegraph Communication with South Africa.—We have frequently pointed out the necessity for a trustworthy cable route to South Africa, a necessity which recent circumstances have proved to be of the first importance. We have every reason to believe that a cable *via* Ascension and St. Helena, besides fulfilling the requirements as regards safety, would also meet with the support of the Admiralty on account of its strategic importance. In the following extract from a contemporary, it will be seen that even the prospect of such a line has excited the jealousy of the "parish-pump" politicians of the islands in question, although it is clear that the laying of such a cable would be of advantage to all concerned. "St. Helena, 'the lonely rock' in the Southern Seas, is clamouring for cable communication and other advantages. A local paper points out that it would be easy for a foreign Power to quietly seize the island, and secure the incoming mail steamer as a prize of war. The recent visit of Sir Francis Evans, M.P., and Sir John Robinson has raised high hopes, and increased the jealousy of 'the carefully nurtured sister island' of Ascension. The latter is certainly a dreary place—despite its far-famed turtles—and it is doubtful whether the sojourners thereon would much resent the St. Helena appellation of 'the cinder heap.'"

CONTRACTS OPEN AND CLOSED.

OPEN.

Ayr.—November 25th. Tenders are invited for the supply and erection of the following plant, for the Electric Lighting Committee; two Lancashire boilers and fittings, mechanical stokers, extensions to economiser, two 200-kilowatt steam alternators and condenser, cables and culverts. The ground plans of plant and specification, with terms and conditions of tenders and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer to the corporation, Ormond House, Great Trinity Lane, London, E.C., on and after November 10th, on payment of a deposit of £2 2s. for each copy.

Denmark.—December 4th. Tenders are invited by the Municipal Authorities of Copenhagen for the supply and erection of the necessary boilers, engines, dynamos, mains, &c., required in connection with a projected central electric lighting station at Vesterbro. Tenders to be directed to the Fourth Division of the Magistracy, Copenhagen.

Derby.—November 17th. The Midland Railway is inviting tenders for railway stores including copper and brass tubes, &c; engine fittings—brass; telegraph instruments; telegraph stay rods, bolts, &c. (galvanised); telegraph and signal wire; gas tubes and fittings—iron; gas fittings—brass; India-rubber brake-pipes, washers, &c., for the Midland Railway Company. Forms of tender may be had on application to Mr. G. Morrall, stores superintendent, Derby.

France.—November 26th. The French Post and Telegraph authorities invite tenders for the supply of 14 tons of tin solder, and 50,000 telegraph pole brackets. Tenders to be directed to the Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Londonderry.—December 1st. The Corporation wants tenders for the supply of carbons for one year, from January 1st, 1897. Particulars to be obtained from Mr. John Christie, city electrical engineer, Guildhall. See "Official Notices."

Maryborough (Ireland).—November 23rd. Tenders are invited for the supply and erection of an electric light installation at Maryborough District Lunatic Asylum. Tenders should be sent to the secretary, Board of Control, Customs House, Dublin. Specifications, &c., will be issued on application to the Office of the Board of Control of Lunatic Asylums, Customs House, Dublin, on deposit of £3 3s. Plans can be seen at the office of the electrical engineer, Mr. Walter Leake, 35, Dame Street, Dublin.

Roumania.—November 16th. The Municipal Authorities of Bucharest are inviting tenders for the supply and erection of two auxiliary steam engines at the hydro-electric central station at Grozaresti. Tenders to be sent to La Mairie, Bucharest, Roumania.

Shoreditch.—November 17th. The Vestry invites tenders for the supply of the best insulated wires and mains for the interior wiring of consumer's premises, insulated iron pipes, junction boxes, switches, &c., &c., for one year. For further particulars apply to Mr. C. H. Doughty, lighting engineer, Old Street, E.C., also see our "Official Notices."

Southampton.—November 13th. The corporation invites tenders from engineers resident within the county borough for supplying and fixing the electric wires and fittings at the municipal offices, Guildhall, and police offices, Southampton, according to specification, which, with the form of tender, may be obtained of Mr. J. H. Lee, A.I.E.E., electric supply station, Back-of-the Walls, Southampton.

South Shields.—November 23rd. The Corporation want tenders for the supply and erection of alternator, engine, transformers, rectifier and extension to switchboard. See our "Official Notices."

St. Olave's, Southwark.—November 23rd. The Board of Works invites tenders for the purchase of a dynamo and accumulators, which may be seen at the Stone Yard, Vine Street, Tooley Street. For further details see our "Official Notices."

Spain.—November 17th. Tenders are being invited until November 17th, by the Municipal Authorities of Alcazar de San Juan (province of Ciudad Real) for the concession for the electric lighting of the town during a period of 30 years. Tenders to be directed to El Secretario del Ayuntamiento de Alcazar de San Juan (Ciudad Real).

West Ham.—November 24th. The Council invites tenders for four steam alternators, mains, transformers, arc lamps, crane, &c. Particulars from the Borough Electrical Engineer (Mr. John J. Steinitz), Town Hall, Stratford.

West Looe (Cornwall).—November 28th. Tenders are invited for the lighting of the parish with either gas, oil, or electricity, for the Parish Council. Information may be obtained of Mr. William Hicks, hon. clerk.

York.—November 30th. The Corporation invites tenders for the supply and erection of a complete electric lighting plant for the Borough, also supplying and laying mains, ditto arc lamps, and running the whole system. Further details from Prof. Kennedy, and from our "Official Notices."

CLOSED.

London, E.C.—The following tenders were sent in for electric wiring and fitting work at the store, Clerkenwell, for the London School Board:—

J. O. Grant & Cocks	£870 0
Electrical and General Engineering Company	789 10
H. F. Joel & Co.	748 0
Wenham & Waters, Limited	699 0
Strode & Co.	687 0
Edmundsons, Limited	649 0
C. A. Hemingway	628 0
Brush Electrical Engineering Company, Limited	598 0
C. E. Spagnoletti & Crookes (accepted)	550 0

Morley.—On the recommendation of Mr. Hammond and the Electric Lighting Committee, the following tenders have been accepted:—Boilers and accessories, Messrs. Holdsworth & Sons, Bradford, £1,499 5s.; engine house plant, Electric Construction Company, £5,731; switchboard and instruments, Electric Construction Company, £600; overhead travelling crane, Bedford Engineering Company, £250; underground work, cables and culverts, Callender's Company, £1,790 8s. 3d.; transformers and switchboard, Electric Construction Company, £822 (lamps and posts, £324); meters, Westinghouse Electric Company, Limited, £114 8s. 9d. Total, £11,131 2s.

NOTES.

Extracting a Penny from a Boys' Œsophagus.—We have before us a radiograph showing a penny in the œsophagus of a boy aged 8½ years of age, which coin has subsequently been successfully extracted with forceps. The history of this case presents some interesting features illustrating the invaluable assistance afforded to surgical diagnosis by radiography. The patient, who had accidentally swallowed the coin in September, 1895, was examined soon after by passing a probane down the œsophagus, but no obstacle to its passage being met with, it was assumed that either no foreign body had been swallowed at all, or that it had already passed into the stomach, and perhaps out of the body. Renewed pains, however, caused the administration of emetics, which were equally fruitless in dislodging or producing any evidence of the supposed swallowed coin. Early in September of this year the boy was taken to the premises of Messrs. A. Hurst & Co., of 53, Leadenhall Street, E.C., to be radiographed, and although surgical examination pointed to the absence of any obstacle in the œsophagus, yet an attempt was made to corroborate or contradict this result. A globular vacuum tube (focus pattern, with additional flat anode) suitable for 4 inches to 6 inches spark, was used, and arranged about 21 inches above the table on which the patient was laid with the back on the photographic plate (Cadett's lightning). An exposure of 11 minutes was then given, and the plate, after development, showed a round body of about 1¼ inches diameter, lodging between the second and fourth dorsal ribs, slightly to the left of the median line. It may be here remarked that a visual examination of the thorax by means of the fluorescent screen, failed to reveal the coin, and the reason is obvious. The coin was really sandwiched between the breastbone (sternum) and the spinal column, so that there is a comparatively *slight* differentiation, which can only be brought out by prolonged exposure and the cumulative action of the rays upon the photographic film. The fact of the outlines of the disc being fairly definite pointed to the probability of its position near the back, as otherwise the respiratory movement would have blurred the outline considerably.

Amalgamation.—Notice is given under date November 7th, 1896, that an extraordinary general meeting of the Manchester Edison-Swan Company, Limited, will be held at the Memorial Hall, Albert Square, Manchester, on 24th inst., at 12 o'clock noon, for the purpose of considering, and, if thought fit, passing the resolution following:—

That it is desirable to amalgamate the undertaking of this company with that of the Edison & Swan United Electric Light Company, Limited, and accordingly that the provisional agreement submitted to this meeting, and made between John Edwin Sharples, on behalf of this company, of the one part, and the Edison & Swan United Electric Light Company, Limited, of the other part, be and the same is hereby approved, and that with a view to such amalgamation this company be wound up voluntarily, and that the liquidator, when appointed, be and he is hereby authorised, pursuant to Section 161 of the Companies' Act, 1862, to adopt the said agreement, and to carry the same into effect with such (if any) modifications as he shall think expedient.

Should the resolution be passed by the requisite majority, it will be submitted for confirmation at a subsequent meeting.

Esmond's Electric Traction System.—At last week's extraordinary general meeting of the British Electric Traction (Pioneer) Company, Limited, Sir Charles Rivers Wilson, the chairman, is reported to have given utterance to the following remarks during the course of his speech:—

Those of you who attended the meeting last February may, perhaps, remember that I referred to the question of supplementing the trolley system by some other perhaps more satisfactory system, as some think it; and I told you that we had acquired certain rights in a valuable American patent known by the name of its inventor, Mr. Esmond. I mentioned then, and I repeat now, that although, for all practical purposes—convenience, economy, and other technical reasons—we consider that the best system—I am speaking now from the point of view of shareholders—is the overhead trolley system, yet I told you that we thought it was advisable to have some other system in reserve for employment in localities where the introduction of the overhead trolley system might be objected to. I will, therefore, tell you what we have done with respect to this Esmond system. By the friendly assistance of the Brush Electrical Engineering Company we have been able to have a full and continued trial of this system. A track has been laid down at the Loughborough works of the Brush Company, and the system has been there subjected to all sorts of experiments and trials in order to test its efficacy. The result is that while in its main lines it has simply carried out the expectations we formed, certain matters of detail require improvement and development; and our engineers have given a great deal of trouble to improving the system as it came to us, and, I believe, with entire success. Therefore, I say, I fully look forward to this—that we shall always have in reserve the surface contact system, which will be applicable where corporations or localities may not think fit to adopt the overhead trolley system.

We cannot but think that it will be wise on the part of the directors of the new company which is being incorporated to acquire the business of the "Pioneer," not to lay too much store on the value of Esmond's patents, the innumerable switching arrangements and complication of wires being, in our opinion, likely to form serious obstacles to the efficient and practical working of this surface contact system. For the benefit of those who wish to investigate the details of Esmond's scheme we may call attention to the ten following patents of the year 1895 in connection with electric traction which have been granted to F. C. Esmond. Those marked * are published and can be obtained at "The Sale Department, H.M. Patent Office, 25, Southampton Buildings, Chancery Lane, W.C." A.D. 1895, Nos. *12,613, *12,614, *12,615, 12,616, 12,617. *18,698, *18,699, 18,700, 18,701, *22,519. In lieu of a surface contact electric tramway, cannot Mr. Garcke and his co-directors, with the financial backing they are able to command, get possession of a promising secondary battery system which could be fostered and developed into a really commercially successful means of locomotion for localities where the trolley is tabooed or deemed unsuitable.

The Auto-Car Race.—No fewer than 54 motor cars of various styles and sizes have been entered to take part in to-morrow's race to Brighton.

The Surrey County Council, acting on the recommendation of a committee, does not see its way to grant permission to the Motor Car Club to run cars over a portion of the roads of the county on the occasion of the London-Brighton race to-morrow. It was thought that the maximum speed allowed was excessive, and that, having regard to the narrowness and crookedness of some of the highways in Surrey, that the width of the cars, which might be 7½ feet, was too great, and that 6 feet should be the maximum width. They further suggested that the person in charge should be duly licensed. The Secretary of State for the Home Department calls public attention to the dangers that may arise from the careless use of those more volatile descriptions of petroleum to which the rules apply, being petroleum to which the Petroleum Act, 1871, applies, and commonly known as "mineral spirit." Not only is the vapour therefrom, which is given off at ordinary temperature, capable of being easily ignited, but it is also capable of forming an explosive mixture. Hence the necessity for strict precautions in dealing with and handling the same, and for the employment of thoroughly sound and properly closed vessels to contain the same, the importance of avoiding the use of naked lights in dangerous proximity to the same or to any place where such petroleum may be kept, and generally of taking precautions to prevent contact of the highly inflammable vapour of this very volatile liquid with any form of artificial light.

The McDonald Primary Battery.—Amongst our business pages will be noticed an advertisement, "The McDonald Patent Electro-Generator and Storage Battery," and from a letter accompanying this, addressed to the Editor by Mr. Urquhart, the secretary and solicitor to the McDonald Patent Battery Syndicate, we cull the following extracts:—"In your issue of last week I notice that you refer to an opinion given by you as to this battery in February, 1895. I have referred to that number, and have read your criticism. I do not desire to make any remark upon that opinion further than to say that you are in error in regard to almost every point raised by you." . . . . "We had the battery thoroughly tested by Mr. Tatlock, the Glasgow City analyst, Dr. Peddie, Assistant Professor of Natural Philosophy, Edinburgh University, and Mr. W. A. Bryson, consulting electrical engineer, Glasgow, and you will find their reports in the enclosed descriptive catalogue. I would also like, if you would refer to the testimonials from Mr. McLachlan, London, perhaps the largest owner of electrically propelled launches in the Kingdom, from Mr. Dawson, Stranraer, and Mr. Gourlay, Isle of Man." . . . . "With a view of demonstrating the applicability of the battery for the propulsion of vessels, the syndicate recently purchased the steam yacht *Medusa*, between 50 and 60 feet long. She is being fitted with batteries and motors, and we expect her to be ready for her trials in about a month." "I have gone into these details for the purpose of satisfying you that the McDonald battery is something better than you represented in your article, and if I have, I would ask you to be so good as to correct, or at all events modify, the opinion which you formerly gave." The battery in the "descriptive catalogue is exactly the same as that shown in the REVIEW for February 22nd, 1895. We emphatically denied at the time that 18 McDonald pint cells would give 35 volts, and now we find Dr. Peddie saying, "in regard to voltage, the cell is practically identical with a Daniell cell," which means, practically, 1 volt. We will not refer at the moment to several other points raised by us—we shall have extreme pleasure in dealing exhaustively with the battery, its tests, and testimonials, in another issue—but merely state that we made no error whatsoever. It might, perhaps, be well to say here that we have no knowledge of E. A. McLachlan, of 55, Brighton Road, Stoke Newington, as the "largest owner of electrically propelled launches in the kingdom," but possibly this is the gentleman who was, we believe, in the employ of Messrs. New & Mayne, and who had something to do with the "rudder motor." The battery is precisely as represented by us, a type of Daniell cell—with which, indeed, Dr. Peddie and Mr. Bryson compare it. We have nothing to correct or modify, but there is much in the "descriptive catalogue and price list, price 4d.," to expand and amplify. We cannot refrain from adding the following delicious morsel:—"But the McDonald generator and storage battery supplies what is lacking in the accumulator and oil engine, and effectually meets the objections inherent in both. . . . . It both generates and accumulates the electricity itself. . . . . There will, of course, be an absorption (?) of zinc, but as only 2½ ounces for 100 watt-hours are used, it will be seen at once that the cost of this will be infinitesimal." The 2½ ounces per 100 watt-hours is the *experience* of Mr. Dawson, who, when testing one cell took the initial voltage but not the final!

Royal Society.—The following is a list of those who have been recommended by the President and Council of the Royal Society for election into the Council for the year 1897 at the anniversary meeting on November 30th:—

President—Sir Joseph Lister, F.R.C.S., D.C.L.; Treasurer—Sir John Evans, K.C.B., D.C.L., LL.D.; Secretaries—Prof. Michael Foster, M.A., M.D., and Prof. Arthur William Rücker, M.A. Foreign Secretary—Edward Frankland, D.C.L., LL.D. Other members of the Council—Prof. William Grylls Adams, M.A., Prof. Thomas Clifford-Allbutt, M.D., Prof. Robert Bellamy Clifton, M.A, William Turner Thiselton-Dyer, C.M.G., Prof. James Alfred Ewing, M.A., Lazarus Fletcher, M.A., Walter Holbrook Gaskell, M.D., Prof. Alfred George Greenhill, M.A., William Huggins, D.C.L., Prof. Charles Lapworth, LL.D., Major Percy Alexander MacMahon, R.A., Prof. Raphael Meldola, F.C.S., Prof. William Ramsay, Ph.D., the Lord Walsingham, M.A., Prof. Walter Frank Raphael Weldon, M.A., and Admiral William James Lloyd Wharton, C.B.

Society of Arts.—The opening meeting of the 143rd Session will be held on Wednesday evening, November 18th, at 8 p.m., when an address will be delivered by Major-General Sir Owen Tudor Burne, K.C.S.I., C.I.E., Chairman of the Council. At the subsequent meetings before Christmas, the following among other papers will be read:—"Recent Developments in Mechanical Road Carriages," by W. Worby Beaumont, M.Inst.C.E.; "The Teaching of Economics," by W. A. S. Hewins, M.A.; "Mining at Great Depths," by Bennett H. Brough, Assoc.R.S.M.

Three Cantor Lectures will be delivered on Monday evenings, at 8 o'clock, by Prof. Vivian B. Lewes, on "The Use of Gas for Domestic Lighting," as follows:—

Lecture I.—November 23rd.—The principles of illumination and the measurement of light—Illuminating value and illuminating effect—Domestic lighting—Flat flame, Argand, and regenerative burners.

Lecture II.—November 30th.—Incandescent mantles and burners—The effect of globes in diffusing and absorbing light—Street lighting—Atmospheric influences and the penetration of light.

Lecture III.—December 7th.—Gaseous illumination where coal-gas is not available—Oil-gas and its properties—Acetylene, its manufacture and use—Acetylene burners and generators—Railway and tram-car lighting.

Prof. W. Chandler Roberts-Austen, C.B., F.R.S., will deliver four Cantor Lectures on "Alloys," on March 15th, 22nd, 29th, April 5th. Six Howard Lectures will be given on Thursday evenings, at 8 o'clock, by Prof. James A. Ewing, M.A., F.R.S., on "The Mechanical Production of Cold," on January 28th, February 4th, 11th, 18th, 25th, March 4th. The annual conversazione of the Society is provisionally fixed for Wednesday, June 23rd.

Rapid Work.—An interesting piece of rapid structural engineering work was accomplished on the Great Eastern Railway system during the early hours of Sunday last. The old railway bridge over the river Ouse, on the London and Norwich main line near Ely, was completely removed, and a new wrought-iron bridge of one span, some 300 tons weight and 130 feet in length, was erected in its place. At about 1.30 a.m. operations were commenced by removing the rails and upper cross timbers. Half an hour later the first of the iron girders, which numbered 20, and weighed about six tons each, was lifted out by powerful steam cranes, and shunted on to trucks. The work was completed at about 7.30 a.m. Preparations were then made for placing the new bridge, which had been previously erected on staging alongside the old bridge, into position. This was effected by slowly hauling the entire superstructure by means of powerful winches fixed on both banks of the river. The bridge itself rested on trolleys running on rails laid along the abutments. This work was completed soon after 9.0 a.m. The next business was to relieve the trolleys of their 300 tons of dead weight, and lower the bridge by powerful hydraulic jacks on to its permanent supports. This done, the rails were laid, the permanent way was made good, and the main line connection completely restored, with a delay to only one train of the ordinary Sunday service.

Serious Accident with Overhead Wires.—The Daily Press says that an extraordinary accident is reported from Tourcoing, in France. A tubular boiler, 15 feet in height, was being conveyed through the town, 16 horses drawing it. Two men were on the car keeping the electric wires overhead clear of the boiler. On coming to a railway arch the men accidentally allowed the wires, fully charged, to come in contact with the boiler. There was immediately a terrible scene, electrical connection being set up with the boiler and chains by which the horses were attached to the car. All the horses were struck down, several being killed and terribly burned. The workmen received violent shocks, from the effects of which some are not expected to recover.

The "Universal" Engine.—We understand that a 165 H.P. "Universal" engine has been working at the Windermere Electricity Supply Station since August 3rd, and has been found, according to the statement of Mr. Frederick Fowkes, the managing director, to effect a very considerable saving in coal. He considers the governing perfect, and testifies that the engine runs silently, and requires very little attention.

The Institution of Junior Engineers.—The inaugural meeting of this Institution's sixteenth session was held on Friday evening, November 6th, at the Westminster Palace Hotel, the chair being taken by the retiring president, Mr. A. Denny, M.I.N.A., of Dumbarton. The preliminary business included the announcement of the admission of 28 new members, the presentation of the Institution premium to Mr. F. J. Bancroft, of Hull, for his paper on "The Stability of Tall Chimneys," and a cordial vote of thanks to Mr. Denny for his services as president. The new president, Mr. A. R. Binnie, M.Inst.C.E., delivered his presidential address. On Friday, December 4th, a paper will be read on "Electric Central Station Working" by Mr. P. W. McDougall, A.I.E.E., of Deptford.

Personal.—Mr. A. G. Cooper, who has resigned his position as Station Superintendent of the Sheffield Electric Light and Power Company, Limited, has joined the staff of Messrs. Davy Brothers, Limited, engine builders and boiler makers, of Park Iron Works, Sheffield, to assist them in constructing engines for electric lighting and traction purposes. The firm hopes, with its long experience in engine building, and Mr. Cooper's practical experience in central station requirements, to place upon the market a substantial and economical engine.

Personal.—Dr. Dawson Turner has been appointed honorary assistant medical electrician to the Edinburgh Royal Infirmary. Dr. Milne Murray has been appointed honorary medical electrician.

Fire.—Messrs. Shand, Mason & Co. ask us to state that, instead of the wholesale destruction of stock referred to in some papers in the report of their fire which occurred last Saturday, the store-room of finished steam fire engines, and, in fact, nearly all the warehouse premises remain intact, and in most departments business can be carried on with but slight interruption. Arrangements are being made for carrying out in another block of buildings the work formerly done in the burnt out premises.

Accident.—Two workmen were somewhat injured at the Mason's Yard Station of the St. James's and Pall Mall Electric Lighting Company, on 7th inst., by a pulley rope—which was holding a cylinder—breaking, the cylinder falling to the ground and being smashed to pieces. The men were struck by pieces of the metal.

Electrical Exhibition at Manchester.—The Council of the Northern Society of Electrical Engineers had under consideration last Tuesday the promotion of an Electrical (primarily) and Mechanical Exhibition, to be opened about June next. It was held that there has been no important electrical exhibition of late, and that many developments have taken place since the last one held at the Crystal Palace. The proposed exhibition, it is thought, will prove of distinct advantage in bringing these developments, especially in the application of electric motors and transmission of power, before the notice of works' managers, foremen of works, and others.

Electric Motors for Printing Machines.—We hear that an important contract for electric motors of the "Castle" type has been received by Messrs. J. H. Holmes and Co., of Newcastle. The total cost of the installation amounts to several thousand pounds, and the motors are intended for use in a well known printing establishment in the City of London.

Inductive Capacity.—Our correspondent (see page 623) who writes on the above subject, has evidently overlooked our article, "The Question of Fast Speed Submarine Cables," which appeared in our issue of October 23rd. Our opinion of Mr. Preece's new cable was there fully expressed, and the more recent publication of the figures, which we thought the contemporary in whose columns they appeared could satisfactorily deal with, only strengthens our views.

The Society of Patent Agents.—The annual general meeting of this society was held at Anderton's Hotel, Fleet Street, London, E.C., on Wednesday evening, when a presidential address was delivered by Mr. J. Sinclair Fairfax (president elect).

The Telephone Service.—A correspondence has been proceeding in the columns of the *Daily Telegraph* on the shortcomings of the telephone service. As usual in such correspondence in general newspapers a great deal of irrelevant matter is discussed. We noted that a technical contemporary in New York, from its own knowledge and experience, regarded some newspaper complaints of the service there as being entirely unfounded. We regret that from our own experience and knowledge here we are unable to make a similar statement. Concurrently with this London newspaper correspondence there has been circulated in Manchester a proof prospectus of the New Mutual Telephone Company, which proposes to apply for a license and start an exchange upon similar lines to those which led to the absorption of the previous Mutual company. This concurrence of agitation and flotation is not unknown. It has existed before, and it will probably now end as before. It is the easiest form of agitation to be dealt with, and having been dealt with, we shall doubtless be given to understand that we have much to be thankful for. Such is not the case. There is much to be desired in the service, and attention should be concentrated on definite complaints and the powers that exist for their removal.

Mercier's Patents, Limited.—This is the title of a new company, with a capital of £6,000, formed for the purpose of acquiring Mr. Maunsell Mercier's inventions relating to electric signalling, which consist of an addition to electric bells and ringing keys by which they are made absolutely air, gas, and water-tight, and for visibly indicating the number of signals transmitted. The apparatus is in use on five railways, and in a number of collieries, and to extensions in these directions, for ships, telephone companies, and wherever bells are exposed to the atmosphere, the directors anticipate that a large demand will be created.

Horseless Carriage Boom.—A writer in *Commerce* of the 11th inst. says:—"Personally, I don't think much of this horseless carriage boom, which will receive an extra leg-up on Saturday next." Neither do we with Mr. H. J. Lawson as commander-in-chief. Some half dozen electrically propelled vehicles are to take part in the procession to Brighton, and if some one on board will only take accurate readings of current and voltage frequently enough, or fix up a self-recording instrument, the results will probably surprise those who so persistently underrate the power which such vehicles will use up.

Alleged Improvement in Storage Batteries.—We learn that Dr. Woodward, of Toronto, has invented a new type of storage battery, which has been designed by him to meet the demand likely to accrue for electrically propelled vehicles. Several test carriages are being worked in Canada by the Canadian Company. It is said that weight for weight the new type of "Woodward multi-tubular traffic cell" has a greater surface and larger output per pound than any battery yet introduced. Patents are being secured in all countries, and as soon as the English patents have been secured, batteries will be submitted to English experts, and a company, we are told, will be formed to manufacture the battery in England.

Concert.—The Electrical Trades Union "second grand concert" will take place at the Clerkenwell New Town Hall on Saturday, November 21st.

St. Paul's Cathedral Lighting.—Experiments are again being made at St. Paul's Cathedral with a view to improving the lighting. Incandescent gas is now being tried.

NEW COMPANIES REGISTERED.

Isle of Thanet Light Railway (Electric) Company Limited (49,678).—Registered November 3rd; capital £1,000 in £10 shares, to promote and obtain the necessary authority to make and maintain railways or tramways in Kent, or elsewhere, to equip and work the same by animal or by electrical or by other mechanical power, and to carry on business as a tramway, omnibus, railway, and electrical company. The subscribers (with one share each) are:—Wm. M. Murphy, 39, Dame Street, Dublin, C.E.; Wm. Anderson, 9, Upper Sackville Street, secretary; J. W. Lombard, 48, Lower Sackville Street, Dublin; F. W. Brady, 26, Upper Pembroke Street,

Dublin; John J. O'Connor, 21, Lower Sackville Street, Dublin; E. Lazards, 83, Cannon Street, E.C., chairman of company; George Richardson, 3, Lombard Court, Lombard Street, E.C., metal broker; Joseph B. Glenn, 7, Poultry, E.C., secretary. Table A mainly applies. Registered by C. H. Stanislas, 187-8, Upper Thames Street, E.C.

Great St. Bernard Railway Concessionary Company, Limited (49,980).—Registered November 3rd, capital £5,000 in £10 shares, to apply to and obtain from the Governments of Italy and of the Swiss Confederations, concessions for the construction and working of a railway over the pass of Great St. Bernard from Aosta, Italy to Martigny in Switzerland, and to supply and work the above with electric centre rail, locomotives. The subscribers (with one share each) are:—J. B. Fell, Leyland Road, Southport, C.E.; E. C. Thompson, Tresco, Eastern Road, Brockley, S.E., surveyor; R. P. Hirst, 121, Southbank Road, Southport, C.E.; D. S. Derry, 22, Great Winchester Street, E.C., banker; G. N. Fell, 11, The Avenue, Bedford Park, W., C.E.; C. F. Lancaster, Silverdale, Vale of Health, Hamptead, gentleman; G. R. Bayliss, Sponton, Derbyshire, C.E. The number of directors not to be less than three, nor more than five; the first are J. B. Fell, R. Blackie, and R. P. Hirst; qualification, one share. Registered by Batten & Co., 32, St. George's Street, S.W.

Traffic Syndicate, Limited (50,004).—Registered November 4th, capital £10,000 in £1 shares, to promote the interests of the industry connected with the placing of cabs and all kinds of vehicles, electrically or mechanically propelled, on the common roads, and to carry on the business of electricians, mechanical engineers, machinists, fitters, founders, millwrights, &c. The subscribers (with one share each) are:—T. G. Norris, 32, Graces Road, Peckham, S.E., clerk; J. P. Eldridge, 7, Brunswick Avenue, New Southgate, clerk; J. C. Bullen, 280, Ramsay Road, Forest Gate, clerk; G. H. Sanderson, 40, Grafton Road, Kentish Town, clerk; W. J. Wrinkley, 12, Elmfield Road, Balham, clerk; A. Mackay, 138, Leadenhall Street, E.C., accountant; P. Horrath, 18, West Bolton Gardens, S.W., gentleman. Registered, without articles of association, by J. T. Eldridge, 7, Brunswick Avenue, New Southgate.

Sleaths, Limited (50,021).—Registered November 6th, with capital £25,000 in £1 shares, to acquire the business of Messrs. Sleath Bros., carried on at Leamington, Warwick, and Stratford, Warwick, to adopt a certain agreement, and to carry on the business of boot manufacturers and dealers, cycle manufacturers, and dealers' engineers, manufacturers of and dealers in electrical and other carriages, motors, &c. The subscribers (with one share each) are:—W. Sleath, 15, Market Place, Warwick, boot and shoe maker; A. Sleath, 50, Brook Street, Warwick, machine agent; E. E. Sleath, 8, Clemens Street, Leamington, cycle agent; A. E. Sleath, 60, Warwick Street, Leamington, cycle agent; Mrs. J. Sleath, 8, Clemens Street, Leamington; Mrs. L. P. Sleath, 50, Brook Street, Warwick; Mrs. E. H. Sleath, 60, Warwick Street, Leamington. The number of directors is not to be less than three, nor more than five; qualification £250; remuneration of chairman, £35, and others, £25 per annum. Registered office, 60, The Parade, Leamington, Warwick.

London Motor Car Works, Limited (50,024).—Registered November 6th; capital £10,000, in £1 shares, to adopt an agreement with J. R. Richards, and to carry on the business of cycle, motor, and car manufacturers, electricians, engineers, machinists, fitters, founders, millwrights, smiths, wire drawers, tube makers, saddlers, rubber manufacturers, &c. The subscribers (with one share each) are: J. R. Richards, Doris Street, Kennington, S.E, engineer; H. Halsey, Henley Park, Surrey, gentlemen; E. Salter, 9, Strand, W.C., jeweller; F. V. L. Matthias, 10, Mecklenburgh Street, W.C., A. D. Southam, 29, Paternoster Row, E.C., engineer; W. H. Rickard, 143, Kennington Road, S.E., gentleman; C. A. Brown, 28—30, Great Eastern Street, E.C., gentleman. Registered without articles of association by C. J. Odhams, 120, Queen Victoria Street, E.C.

Penzance Gas Company, Limited (50,038).—Registered November 7th, with a capital of £50,000, in £10 shares, to acquire the business and undertaking carried on at Penzance, Cornwall, by the Penzance Gas Company, to enter into an agreement with the said company to manufacture, sell, and supply light in the town of Penzance and elsewhere, and to carry on the business of an electric light company in all its branches. The subscribers (with one share each) are:—J. R. Branwell, Penlee, Penzance, gentleman; W. F. Rowe, Cliff House, Penzance, gentleman; J. H. Tonking, 60, Morrah Road, Penzance, merchant; R. H. Bodilly, West Lodge, Penzance, gentleman; C. Bengelley, 30, Market Place, Penzance, merchant; P. T. Chirgwin, 7, Market Place, Penzance, grocer; J. Polsue, Alverton Street, Penzance, merchant. The number of directors is not to be less than three, nor more than seven; the first are the above seven subscribers. Qualification, £150; remuneration as the company may decide. Registered by Jordan & Sons, Limited, 120, Chancery Lane, W.C. Registered office, 95, Market Jew Street, Penzance.

Phœnix Accumulator Syndicate, Limited (50,033). Registered November 6th, with a capital of £2,500 in £1 shares, to carry on the business of electrical and mechanical engineers, manufacturers of and dealers in electric, magnetic, telephone, telegraphic, and other appliances and apparatus, and of steam, hydraulic, pneumatic, and other engines, and to carry on the business of an electric motor, light, and power company. The subscribers (with one share each) are:—Wm. Jordan, 55, Highbury Park, N., agent; N. C. Newman, 230, Lancaster Road, W., clerk; H. W. Jordan, 120, Chancery Lane, W.C., agent; G. C. Hayward, 6, Torriano Gardens, N.W., clerk; A. E. Jordan, 120, Chancery Lane, W.C., cashier; F. Shields, 6, Bell Yard, Temple Bar, director of company; W. T. Jones, 17, Penford Street, S.E., clerk. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first. Registered by Jordan & Sons, Limited, 120, Chancery Lane, W.C.

Australian Cycle and Motor Company, Limited (50,044).—Registered November 7th, capital £75,000 in £1 shares, to adopt an agreement dated November 6th, with W. Rudd, and to carry on the business of cycle motor and motor car manufacturers, dealers, and repairers, launch, boat, and vessel builders, mechanical and electrical engineers, machinists, fitters, millwrights, founders, wire drawers, tube makers, &c. The subscribers (with one share each) are:—S. E. Newman, 72, Romilly Road, Finsbury Park, N., clerk; B. Wilkinson, 4, Wells Road, Regent's Park, W., solicitor; G. Reeson, 2, Clarendon Terrace, W., clerk; C. C. Wells, 1, Millfield's Road, Clapton Park, N., clerk; E. Sorrel, 50, Idmiston Road, Stratford, N.E., clerk; C. Luff, Woodham, Addleston, Surrey, clerk; A. Blackman, 18, Argyle Square, W.C., solicitor. The number of directors not to be less than two, nor more than seven. The subscribers are to appoint the first. Qualification £100, remuneration £100 each per annum (£150 for the chairman). Registered office, Worcester House, Walbrook, E.C.

CITY NOTES.

British Electric Traction (Pioneer) Company, Limited.

Sir C. Rivers Wilson presided, yesterday week, over an extraordinary general meeting of this company, held at Winchester House, Old Broad Street, E.C., to consider a resolution approving a contract for selling the company's undertaking and assets to the British Electric Traction Company, Limited.

In proposing the resolution, the Chairman reminded them that the company came into existence less than a year ago, and that it was only a little more than nine months since he explained to them the company's policy. He thought they might congratulate themselves upon the fact that within so limited a period, comparatively speaking, they had been able to achieve such results as to justify them in going forward with the formation of a larger company. The work done had almost exceeded his expectations. They had formed and registered a new company, in which they proposed to perpetuate the name of the existing company, omitting the word Pioneer. They proposed that the new company should have a capital of £600,000, divided into 30,000 6 per cent. cumulative preference shares and 30,000 ordinary shares of £10 each, and power would be taken to increase the share capital periodically, as might be found necessary. The directors would also have the power to issue debentures to the extent of one-half the subscribed capital for the time being. The new company would take over and carry on the business of the present company, and the directors would be the same. There would, therefore, be no break in the continuity of the business. The Pioneer Company had become the possessor of certain provisional orders authorising the construction of certain undertakings, and by the provisions of the Tramways Act, 1870, it was not feasible to transfer such undertakings until six months after they were completed. For all practical purposes, however, the present company would become one with the new company, but for the reason mentioned they would have to maintain, technically, the life of the Pioneer Company for a limited period. The terms on which the business of the existing company was to be transferred included the payment by the new company of £25,000. The paid-up capital of the Pioneer Company was £20,000, or £4 per share on 5,000 shares. The purchase price would therefore be equivalent to a return of the paid-up capital with a bonus of £1 per share. The new company would take over and discharge all the liabilities of the present company, and the £25,000 would therefore be paid to the shareholders free from any deduction. In addition, the directors had stipulated that the shareholders in the Pioneer Company should have a preference in the allotment of shares in the new company to the extent of their present respective holdings, and as it was expected that the capital of the new company would be largely over-subscribed, they thought that this preference was a valuable concession. The Electric and General Investment Company, which was arranging the issue of the new capital, would relieve the shareholders in the existing company of the necessity to remit cash in payment of the application money in respect of the new shares, as the Electric and General Company had agreed to pay on behalf of the Pioneer shareholders the sum due on application for new shares up to the amount of £5 per Pioneer share. With regard to the assets they were able to transfer to the new company he could give some really satisfactory information. First of all, there were several valuable provisional orders and Acts of Parliament for the carrying out of various electric traction undertakings. They had obtained a provisional order, confirmed by Act of Parliament, for the construction of electric tramways from Oldham through Ashton to Hyde, a populous district in the neighbourhood of Manchester, where further tramway facilities are much wanted; and they were at the present time negotiating a contract with the Corporation of Ashton to supply them with the necessary electric current. The extent of the lines there will be about seven miles. Another provisional order, also confirmed by Act of Parliament, is for the construction of electric tramways in the Potteries district embracing an extent of about 12½ miles. These tramways are extensions of the existing North Staffordshire Tramway Company's system, and with respect to that system they had made an excellent arrangement with that company by which they would obtain the contract for the equipment of their lines electrically. For that purpose they had entered into a good and profitable contract with the Brush Electrical Engineering Company, who are to provide the plant, machinery, rolling stock, and other necessary appliances. They had also under-

taken on profitable terms to work these lines. There was another provisional contract that they had entered into with the Corporation of Longton to equip electrically the existing tramways within their borough, and to carry out certain extensions of about three miles in one direction and three miles in another direction. Altogether it is expected that in the Potteries district of North Staffordshire there will be, in the course of the next few years, a network of electric tramways, in which the new company will be interested, extending over about 35 miles, and connecting the important industrial centres of Longton, Stoke-on-Trent, Hanley, Burslem, Newcastle-under-Lyme, Tunstall, and other places in the vicinity. They had also obtained an Act of Parliament to construct a short electrical tramway from Kidderminster to Stourport, and they had secured a provisional order authorising extensions of electrical tramways at Hartlepool. These various undertakings specified embrace a mileage of about 36 miles, and these were absolute assets. They are schemes which will undoubtedly be carried out, and carried out very profitably by the new company. In addition to these absolutely ascertained assets, they were handing over to the new company the result of all their various other negotiations, and the negotiations themselves, and it was because he wished to speak with great reserve and prudence that he did not enter into some developments as to negotiations which had been undertaken in other directions. Therefore he might say that they had, during the period they had been at work, been able to bring to a more or less successful conclusion negotiations embracing 120 miles of electric lines. He referred at their last meeting to the question of supplementing the overhead trolley system by some other perhaps more satisfactory system, as some thought it, and he at the same time informed them that they had acquired certain rights in a valuable American patent known by the name of its inventor—Mr. Esmond. Although they considered that the best system was the overhead trolley system, they thought it advisable to have some other system in reserve for employment in localities where the introduction of the overhead system might be objected to. By the friendly assistance of the Brush Electrical Engineering Company they had been able to have a full trial of the Esmond system. A track had been laid down at the Loughborough works of the Brush Company, and the system had been subjected to all sorts of experiment and trials in order to test its efficiency. While in its main lines it had amply fulfilled the expectations they formed of it, certain matters of detail had required improvement, and, he believed, their engineers had succeeded in effecting this. Therefore he looked fully forward to this, that they would always have in reserve the surface contact system, which would be applicable where corporations or localities might not think fit to adopt the overhead trolley system. They looked, however, to the overhead trolley system as being that which was most likely to be generally adopted, and it would certainly, if adopted, yield the best financial results. A great deal of the prejudice which formerly existed against the trolley system was, he thought, being gradually removed, in consequence of the marked improvements which had been introduced in its working, more especially in continental cities. The solicitor (Mr. Morse) had very carefully drawn up the agreement which the shareholders were asked to approve, and of which he had given them the substance; but any shareholder who desired to go further into the matter would find the agreement open to his inspection, and Mr. Morse would give any further explanation that might be required.

The Earl of Suffolk and Berkshire seconded the motion, which was carried unanimously.

Mr. George Herring afterwards proposed a resolution fixing the remuneration of the directors of the Pioneer Company at £1,000, to be paid upon the formation of the new company. When the company was formed, he and all who helped in its promotion believed that it was almost certain of success, but in all business concerns there was a chance of failure. The directors intimated that in that case they would forego any remuneration; but in the event of success he expressed his conviction that the shareholders would behave liberally towards the board. In the new company the remuneration was fixed by the articles of association at £2,000 for the first year. If the company had the power to raise the money that would be necessary, he would urge them not to part with their property; but they had not this power, and in a business such as he saw in the future, their £50,000 or £100,000 would be absolutely ridiculous. In electrical tramways in America about $400,000,000 was already invested, and very large sums were similarly invested on the Continent.

Mr. Fisher seconded the motion, which was carried unanimously.

The Chairman afterwards stated that the work was of such intense interest that in one sense it had been a labour of love. He believed they were at the outset of a very great undertaking. Electric traction in this country was entirely in its infancy, but they looked forward with satisfaction to the enormous field before them. He did not think it was to be regretted that so little had been done in this country, because they would be able to profit by the experience of other countries.

A special vote of thanks was passed to the managing director (Mr. Garcke) for the valuable services he had rendered to the company.

Western and Brazilian Telegraph Company, Limited.

Mr. Andrews presided at the ordinary general meeting of this company, held at Winchester House yesterday.

After the formal notices had been read, the Chairman said that during the last half-year, ending June 1st, the receipts amounted to £71,082, against £84,936 for the corresponding period showing a decrease of £13,854. The expenses for the same period, respectively, were £37,428, against £37,894, showing a decrease of £436. There was also the non-recurrent item arising out of the Buda Pesth Convention. Of this total, there were 10 items in the accounts showing increases, and 12 showing decreases. The outcome of the accounts, shortly, was that they had a balance carried down of £33,653, to which they had to add £4,952 brought forward from last half-year, together making £38,608. Against this sum had to be charged £750 for debenture interest. Deducting these items, they had left £181,306, out of which they were able to recommend a dividend at the rate of 2 per cent. The directors felt that it was a beggarly return for the large capital that they had invested, and for the splendid system they were maintaining there, and for the almost inestimable services they were rendering to the country. They would remember that at the last general meeting he said that the half year would not turn out less favourable than the half-year they were then dealing with. The premonition had been unfortunately justified, because there was not only a decrease in the revenue, but they had to record, for the first time, a falling off in the number of words transmitted over the cables. If the number of words had gone on increasing as it had done previously, they would have done rather better, but the long continuance of the very unfavourable exchange had begun to put a strain upon the business relations in Brazil, and consequently work was not quite as active as it had been, and he was afraid they could look for no improvement in their position until the country itself showed signs of improvement. The current half-year as far as they could see was likely to be even less encouraging than the one with which they were dealing. The exchange had been going lower and lower until it had reached the record price of $7\frac{1}{16}$d. They must of course share in the temporary distresses of the country, and he trusted they would share in its more permanent prosperity. The country was rich, and its undeveloped resources were great. The reorganisation of the Government of an immense territory was not to be achieved in a day; it was a long period in the history of their company, but was short in the history of a country. There was a little light, he thought, in consequence of the resolution passed at the Buda Pesth Conference, which was to the effect, that countries of the Union which had the franc as their monetary unit should have fixed for the collection of their rates an equivalent approaching as nearly as possible the value of the franc in gold. When these rules came into operation he trusted the anomalies existing in the tariffs would be swept away. The purchase of their lines by the Government still hung fire, but the laws were kept alive, evidently with the idea, should the opportunity arise, of their being exercised.

The resolution for the adoption of the report and accounts, and for the payment of dividend, was then put to the meeting, and after a little discussion, was carried.

The United Electric Wire and Telegraph Works, Limited.—Mr. J. Boss, the secretary of this company, whose offices are at 14A, Clerkenwell Green, E.C., informs us that in accordance with the resolution passed on October 29th, the directors have decided to make a further issue of ordinary shares of £1 each of this company's capital, the entire proceeds to be used as working capital. The shares will be issued at par, and will rank for dividend at the end of the financial year with the existing ordinary share capital of the company. An advance circular has been issued to customers. Applications have to be made by 21st inst.

British Electric Traction Company, Limited.—In our advertisement columns will be found full details of this company, which has been formed with a share capital of £600,000, divided into 30,000 6 per cent. cumulative preference, and 30,000 ordinary shares of £10 each. As is shown in our City Notes, this company has been formed to acquire the business of the British Electric Traction (Pioneer) Company, but we would refer our readers to the report of the Pioneer Company's meeting, and to the advertisement for further details.

West India and Panama Telegraph Company, Limited.—The report for the past half-year states that the revenue amounted to £42,317, and the net profit to £20,036. The sum of £1,000 is placed to reserve, and after payment of interest upon the first and second preference capital, a dividend of 1s. 6d. per share is proposed upon the ordinary shares.

Chicago Edison Company.—Letters of allotment for the issue of $1,200,000 first mortgage 5 per cent. 30-year gold bonds of the Chicago Edison Company have been posted.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending November 8th, 1896, were £1,086; week ending November 10th, 1895, £1,009; increase, £77; total receipts for half-year, 1896, £17,747; corresponding period, 1895, £16,658; increase, £1,089.

The Great Northern Telegraph Company. The receipts in October, 1896, amounted to £25,600; January 1st to October 31st, 1896, £237,600; corresponding months, 1895, £261,600; corresponding months, 1894, £234,600.

The Liverpool Overhead Railway Company. The receipts for the week ending November 8th, 1896, amounted to £1,065; corresponding week last year, £1,068; increase, £2.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 6th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,630.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Nov. 4th.	Closing Quotation, Nov. 11th.	Business done during week ended Nov. 11th, 1896. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104	100 —104	101¾	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	8½— 9½	8½— 9½	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	51 — 54	52 — 55	54	54
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	96 — 97	96½ — 97½	97½	96
2,993,560£	Do. do. Defd.	Stock	...	...	...	9½ — 10	10⅜ — 11⅛	11⅜	9⅞
130,000	Brazilian Submarine Teleg., Ltd.	10	6½%	7 %	7 %	14⅜ — 15¼	14⅜ — 15¼	15¼	14 13/16
75,000£	Do. do. 5 %, Debs., 2nd series, 1906 ...	100	5 %	5 %	5 %	112 —116	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	...	2½%	4 %	3¼ — 3⅜	3¼ — 3⅜	3⅜	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	145 —150	157 —162	160½	...
224,850	Consolidated Telep. Const. and Main., Ltd. ...	10/-	2 %	1½%	1½%	3/16 — 3/16	3/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	11½ — 12⅛	11½ — 12⅛	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½ — 19½	18½ — 19½	18⅜	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½ — 4⅛	3½ — 4⅛	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	..	..
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	4½%	107 —110 %	107 —110%	...	
60,710	Direct United States Cable, Ltd.	20	2⅝%	2 %	2¼%	9 — 9⅛	9¼ — 9⅜	9⅜	9 5/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	17¼ — 17⅜	17¼ — 17⅜	17⅜	17⅜
70,000	Do. 6 % Cum. Pref.	10	6 %	6 %	6	18½ — 19½xd	18½ — 19½	...	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	104 —107	105 —108	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	128 —131	126 —129	128¼	127
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17¼ — 17¾	17¼ — 17¾	17⅜	17 5/16
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	100 —104	100 —104	104⅛	102⅜
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	130 —133	129 —132	131	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	101 —105	101 —105	102⅜	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	102 —105	102 —105	104½	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	106 —109	106 —109	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	108 —111 %	108 —111 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝%	4⅛%	4½%	10⅜ — 11¼	11 — 11½	11¼	11
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	17¼ — 17¾	17¼ — 17¾	17⅞	...
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	10 %	24 — 25	24 — 25	24¼	24⅛
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	53 — 55	53 — 56	53¾	53½
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs. ...	100	6 %	6 %	6 %	109 —112	109 —112	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	4 %	2 — 2¼	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5 %	5½%	7⅛ — 7⅜	7⅛ — 7⅜	7¼	7⅛
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	17⅜	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅜ — 7	6⅜ — 7	6 15/16	6⅜
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	106 —109	105 —108	10 ½	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4¼%	5 %	11/16 — 13/16	11/16 — 13/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 —111	108 — 111	...	...
11,839	Reuter's Ltd.	8	0 %	nil	5 %	7 — 8xd	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	138 —143	139	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	4 %	3½— 3⅝	3½— 3⅝	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	101 —106	101 —106	102½	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	nil	4 %	5 — 6	5 — 6	...	...
238,360£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	103 —106	104½	...
30,000	West Coast of America Teleg., Ltd.	10	nil	nil	nil	½ - 1½	½ - 1½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	8 %	98 -103	97 -103	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	3 %	7⅜ — 8¼	7⅜ — 8¼	8¼	7⅞
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½ — 7	6½ — 7	6 13/16	6⅝
33,129	Do. do. do. Def. Ord.... ...	7½	...	1 %	1 %	1¾ — 2¼	1¾ — 2¼	1¾	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	1⅞	1⅞	1⅞	1⅛ - 1⅜	1⅛ - 1⅜	1 9/16	1⅜
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11⅜ - 12	11⅜ - 12¼	...	...
4,569	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½ - 10½	9½ - 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	108 —111	108 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	107 —112	107 —112	...	...
164,300£	Do. do. 6 % Ster. Bonds ...	100	6 %	6 %	6 %	100 105	100 —105		...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	9½ - 10	9½ — 10	9 11/16	9⅝
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	7⅞ - 8¼	7⅞ — 8¼	8 1/16	8
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4½%	114 —117	114 —117	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	16 — 17	16 - 17	16⅞	16⅝
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 — 18	17 — 18	17⅝	17½
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	130 —135	130 —135	132	131
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	...	nil	8½ - 9½	8½ — 9½	...	...
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	...	6 %	13⅜ — 14½	13⅜ — 14½	14⅛	13 15/16
10,000	Do. do. do. iss. at 2 pm., all paid ...	10	...	...	...	7½ — 8½	7½ — 8½	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	4 %	13 — 14xd	13 — 14	13 7/16	13 3/16
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem., £1 paid	10	...	...	...	6½ — 7	6½ — 7	...	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	121 —124	121 —124	122½	120
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	11½ — 12½	10½ — 11½	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	12 — 13	12 — 13	12¼	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10⅞	10 1/16
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	106 —109	106 —109	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	4 %	5 %	7 %	10½ — 11½	10½ — 11½	11¼	10⅝

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—Continued.

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Nov. 4th.	Closing Quotation Nov. 11th.	Business done during week ended Nov. 11th, 1896. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	5 %§	2½%	...	⅞— 1⅛	⅞— 1⅛	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %§	3 %	...	1 — 1¼	1 — 1¼	1¼	...
125,000	Do. do. 4½ % Perp. Deb. Stock.	Stock	4½%	4½%	...	110 —113	110 —113	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	97 — 101	96 —100	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10½	10½
207,649	Do. do. do. £4 paid	10	...	...	...	4 — 4¼	4 — 4¼	4⅜	...
630,000	City and South London Railway	Stock	1½%	1½%	1 3/16%	50 — 52	50 — 52	51	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 %§	*nil*	*nil*	2 — 2½	2 — 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	5 %	1⅝— 2¼	1⅝— 2¼	1⅝	...
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	5 %	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	4½%	103 —106	103 —106	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	5 %	1½— 1⅝	1½— 1⅝	1½	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2½— 3	2½— 3	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	⅜— ⅝	⅜— ⅝	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅛— ⅜	⅛— ⅜	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	10½%	10½— 11½	10½— 11½	...	
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	17 — 18	17 — 18	18	17½
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	110 —115	109 —114	...	...
56,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	21 — 22	21 — 22	21½	21
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —108	105 —108xd	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅞%	13⅜— 13½	13⅜— 13½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16⅞— 17⅜	16⅞— 17⅜	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	39 — 42	39 — 42	41	40
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	..	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	7½— 8¼	7½— 8¼	8¼	7⅞

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1893—0%; 1891—7½; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 8, £5 (fully paid) 9¼.
Electric Construction Corporation, 6 % Debentures, 103—105.
House-to-House Company (£5 paid), 3⅞—4⅛.
Do. do. 7 % Preference, of £5, 8¼—9.
Do. do. 4½% Debentures of £100 109—111.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 9¼—10; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8⅝.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 7½—8.

* From Birmingham Share List.

Bank rate of discount, 4 per cent. (October 22nd, 1896).

TRIPLE OR COMPOUND ENGINES.

That the most elaborate machinery is not commercially the most economical, is well seen in the modern steam engine with high pressure steam. Looked after in a manner to preserve it in first class condition, the triple-expansion engine is, under proper conditions, more economical than the compound engine. Used at sea, where every ton of weight saved in the machinery may mean a ton more of paying load, it will pay to employ skill to preserve the engine at its highest condition, but space and weight have less meaning ashore, and Mr. Longridge, in his latest report of his Boiler Insurance Company, details certain trials he has made to show that at low prices for coal the compound engine may be the better type to adopt.

The opportunity offered of changing the cylinders of a McNaughted beam engine of 200 H.P. The new cylinders of 36 and 17 inches diameter were jacketed with ribs on the inner liners, and steam of 135 lbs. was employed. In one trial the total steam consumption was only 12·82 lbs. per H.P. hour, and of this amount the jackets accounted for 1·53 lb. Considering the speed, only 34 revolutions per minute, this result is very good, and seems to show that the compound system as distinguished from the triple can be advantageously afforded steam of higher than ordinarily accepted pressures, that in fact there is perhaps too great haste to add a third cylinder, just as in early days a second cylinder was too often added needlessly to work steam that did not demand compound working. At the end of the stroke the amount of moisture in the steam is given at 11 to 12 per cent., which shows good action of the jackets, and, as in the slow running pumping engine of Mr. Leavitt, seems to dispose of the contention that economy demands frequent reciprocative action. Frequent reciprocation abolishes the effect of jackets or renders them unnecessary; but clearly, slow speed, if it demands a jacket, enables the jacket to act, and jackets are by no means abnormally costly, and it is as well to know that *properly worked jackets* and slow speed can still be relied upon to give economy as sure as any that can be had at the pressure. We have previously commented on Mr. Longridge's advocacy of a minimum of internal cylinder surface. In these new cylinders this point has been attended to, and everything has been done to reduce condensation, while the action of the jackets has equally been made as complete as possible.

A separator was placed close to the H.P. cylinder. The following figures will be of interest in reference to the clearance volumes and surfaces:—

	High pressure.	Low pressure.
1. Clearance surface ÷ piston displacement ...	0·96	0·66
2. Surface exposed at cut-off ÷ piston displacement	1·54	1·21
3. Clearance volume per cent. of piston displacement	3·45	2·70
4. Weight of steam admitted per stroke—lbs.	·613	·613
5. Number of expansions...	6·25	3·30
6. Clearance surface per pound of steam admitted—square feet	11·9	51·10
7. Surface exposed up to cut-off per pound of steam admitted	19·7	61·2

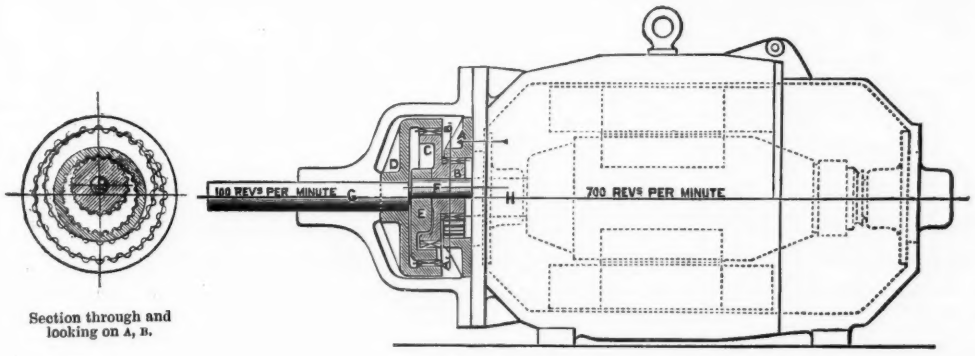
Discounting the specially good vacuum, Mr. Longridge concludes that the steam consumption of a good compound engine at 145 lbs. absolute pressure may be taken at 13½ lbs. per I.H.P. hour.

The steam should also have a considerable velocity through the superheating tubes. As recent experiments have shown that there is loss of head in driving heat both through metal as well as into it, the use of thick superheater pipes is wrong, and the best results both in efficiency and durability should be obtained with small pipes of thin substance. With small pipes, the velocity and area are both secured. With large pipes the velocity is seriously reduced, and the cooling of the thicker metal is disproportionately lessened. We are glad to see Mr. Longridge recognises the fact that heat is not so

freely passed through thick plates as through thin ones, and that the mere surface resistance is not the only resistance that is encountered, as has been too frequently stated to be the case. The more recent conclusion is certainly more in line with practical observation, though of this latter there is so often the obscuring effect of scale to be discounted, that perhaps no serious reliance can be placed on mere observation unsupported by carefully conducted experiment.

A NEW REDUCING GEAR.

Messrs. Mavor & Coulson, are putting on the market in connection with their electric motors a new patent gear for reduction or increase of speed. They have acquired the sole right of use of this gear with electric motors from the inventor, Mr. J. MacEwan Ross, of the firm of R. G. Ross & Son, Glasgow. The gear may either be fitted within a case bolted to the end of the motor, or in a separate gear box bolted to the base plate. One form of the gear is shown on the accompanying illustrations, figs. 1 and 2. In this case the gear box is bolted direct to the casing of a motor enclosed in its own steel shell, the whole forming a very compact and handy apparatus.



Figs. 1 and 2.

In fig. 3 is shown a 30 horse-power gear as arranged for application to an open type motor.

The arrangement—shown in detail in figs. 1 and 2—consists of an internal toothed wheel, A, which is fixed to the casing concentrically with the motor shaft, H. On the end of the shaft, H, a crank pin, F, is formed which carries the two pinions, B and C, which are cast together in one piece. The pinion, B, gears into the fixed wheel, A, while the pinion, C, of larger diameter gears into the internal wheel, D, which is keyed to the low speed shaft, G. As the difference in diameters of the wheels in each pair is exactly equal to twice the throw of the crank when the motor shaft revolves, B rolls round in gear with the internal fixed wheel, A, and B and C revolve freely on the crank, F, the amount of forward motion at each revolution of the crank being determined by the relation between the numbers of teeth in A and B. The internal wheel, D, carrying the shaft, G, and revolving with it in the fixed bearing attached to the gear box is driven by wheel, C, the ratio between the motions of these wheels again being determined by the ratio between the numbers of teeth in C and D respectively. On the crank pin, F, a back balance weight, E, is fixed to secure smooth running. In another arrangement the balance weight may be formed in the disc carrying the crank pin, as shown in fig. 3.

There is practically no limit to the ratio of reduction which can be obtained by the use of this gear, and as the whole works with a rolling motion the loss due to friction is reduced to a minimum, and with wheels taken direct from the sand the noise is considerably less than with ordinary spur gear.

A converse arrangement is practicable by which the speed may be increased from the driving to the driven shaft.

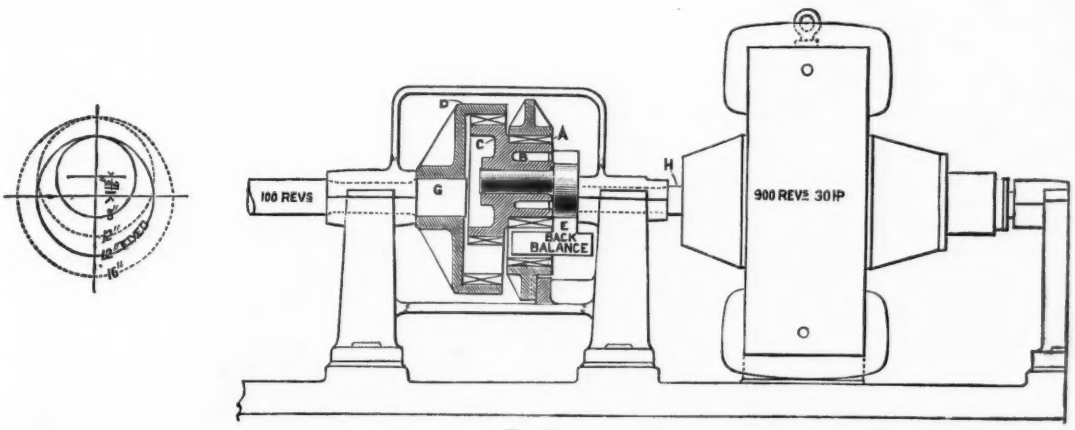
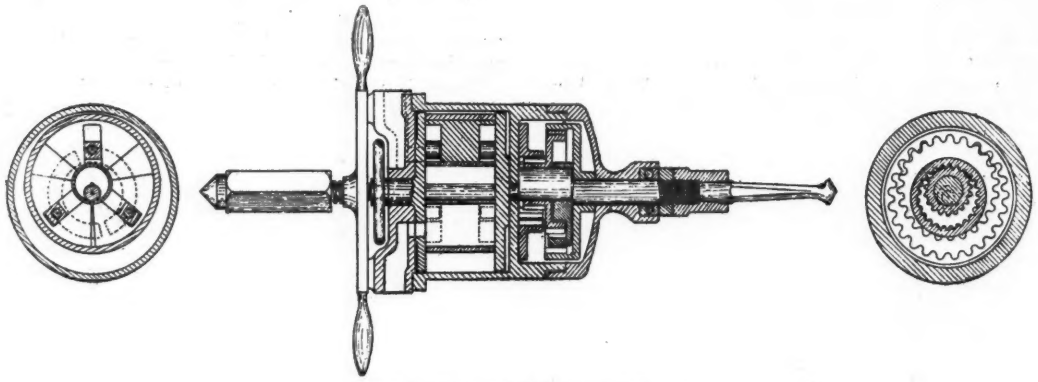


Fig. 3.

This gear forms a self-contained, compact, and portable means of applying electric motors to purposes requiring comparatively slow rotary speeds. The efficiency is very much higher than that of worm gear, and, so far as experimental results have been attained, it appears to be equal in efficiency to the best spur gearing. Fig. 4 shows the application of the gear to a portable drilling apparatus as an example of one of the many uses to which it can be put. Figs. 5 and 6 show the gear applied to a portable drill the motor being in this case driven by compressed air.

RAILWAY SPEEDS.

The *Engineer*, discussing the question of railway speeds, points out how very much the top speed must exceed the average when there are only a few slow downs. This, *apropos* of the recent accident at Preston, which seems to have arisen from the impossibility of keeping time and slowing down at the Preston curve. It is 15½ miles from Wigan to Preston, and 21 miles further to Lancaster. Yet the allowed time is only 16 minutes to Preston, and another 22 minutes to Lancaster; speed, 56¾ and 57¼ miles per hour, with a slack to 10 miles speed for a length of ¾ mile at Preston. Allowing for this, for starting from rest at Wigan and for the heavy grades, it is seen to be impossible to cover the distance in the time, for the running must average 75½ miles per hour, or else that 19 miles of the distance to Lancaster must be run at a speed of 72 to 73 miles per hour. We need not follow our contemporaries reasonings throughout. Its object is to show that the management is at fault, and could not possibly have understood the engineering question, or they would never have timed the Wigan to Lancaster at 38 minutes for 36½ miles, the train starting from rest at Wigan. The Heilmann engine might do such a duty, were it worth while to use so complicated an arrangement, which is equivalent to saying that an electrical locomotive would do the work. It is just the one difficulty of acceleration that bars the way to continuous, or, rather, average high speeds on steam railroads, and renders them possible on electrically-operated lines. What is wanted in railway work is not the rapid running down hill that characterises all our high speed trains when making fast time over an undulating line; but an ability to make good time up hill. The most powerful steam locomotives fail to make high speed, comparatively speaking, up even moderate gradients. They cannot exert the power to do so, or they cannot manufacture steam to do the heavy work. Against the possibility are all the elements of grate surface, blast area, cylinder area, and valve gear, which go to make a locomotive what it is—a machine of wide capabilities, but not capable of everything. Electric working differs in that its hill-climbing qualities can be used when desired simply by drawing upon the power of a central station, the limit of which is beyond even the electric locomotive's demands. With a train of 150 tons, an ordinary engine cannot, it is claimed, attain a speed of 60 miles per hour in a less distance than 4 miles. To traverse this distance, and finish up at a 60 miles velocity requires, of course, 8 minutes, so that on a run at 60 miles speed a start loses 4 minutes, and the loss simply means lack of acceleration power. The cylinders cannot, for reasons of economy, be doubled in size or number, and any better acceleration is, therefore, not to be thought of with steam. Stations cannot always be placed just at the summit of two opposite gradients, and even then the effect of a gradient in assisting acceleration is comparatively small. What is needed is power, and here electrical working comes into the question, and offers us a solution the merits of which are at least higher than those of any other system.



Figs. 5 and 6.—New Reducing Gear.

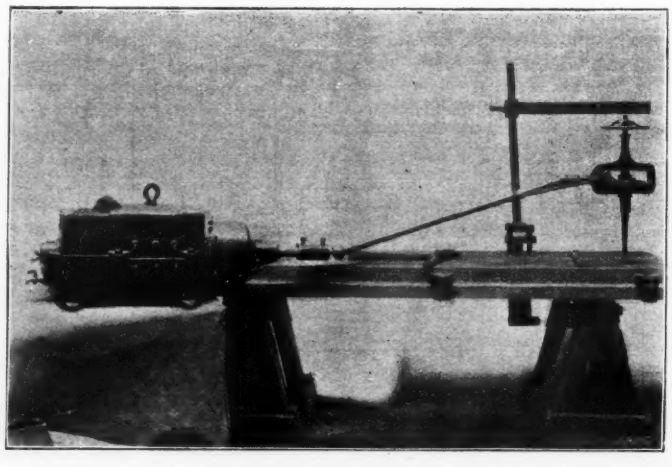


Fig. 4.—New Reducing Gear.

WHAT ELECTRIC LIGHTING REALLY COSTS.

Much has been written and said as to what is the comparative cost of gas and electricity. Many bold enthusiasts have not hesitated to declare that, taking into account the great advantages of electric lighting that accrue to health and whitewash, electricity is not one whit dearer than gas. We have a due appreciation of the value of this argument; it is useless to deny that where electric lighting has superseded gas in large establishments the health of the employés has materially improved, and, if it were necessary, numerous instances could be cited to demonstrate this fact. That unintentional enemy of mankind, the gas man, on the other hand, has said, and we are afraid he cannot be gainsaid, that light for light, electricity is much dearer than gas. Without attempting to combat this view by the aid of theoretical figures, it occurred to us that a better way of ascertaining the real cost of electricity was to apply through the central station engineer to the consumer and ask him point blank what he formerly paid for gas, and what he now pays for electricity. We are quite aware that all sorts of objections can be urged against such a course, especially by our friends the gas people, but it seems to us that if we can find two or three instances of consumers' electricity bills being no more, or very little more, than their previous gas accounts, we are entitled to mention them. A number of central station men were taken into our confidence, and we cannot allow this opportunity to pass without recognition of

the aid they have rendered to us in collecting statistics. Many people objected to our enquiries much in the same way as maiden ladies object to the personal questions of the census officer. The spirit of the Heathen Chinee possessed others, for they were unwilling to admit that electricity cost them no more than gas, especially when reductions in the price per unit were in the air. The result of our inquisition has far exceeded the most sanguine expectations, and it is no exaggeration to say that no matter what the town may be, there are numerous consumers whose electricity costs them no more than gas. Nor does this necessarily imply that less light is used; indeed, it is impossible to conceive that any person who substitutes electricity for gas could go in for less illumination. The use of gas under the most favourable conditions involves unpreventable waste, while economy is possible with electricity.

In the course of these interesting revelations, it may be occasionally necessary not to publish names, but our readers may rely on the figures, being substantiated generally by the electrical engineer of the district from which the results come.

Before we pass on, however, it will be interesting to quote two letters from central station engineers, which are based on general experience and not from actual instances. We quote them just to show how different are the results when special enquiries are made :—

"We have no positive information as to the actual relative cost to our consumers of gas and the electric light, but the general feeling seems to be that the cost of the electric light is about double that of gas, light for light, but with a considerable and obvious advantage from its use, which fully compensates for the increased cost."

"I have no reliable data as to the previous gas bills paid by our consumers; further, in a great many instances the lighting power is materially increased, and information would be valueless without making due allowance for this. Comparisons of this kind are often apt to be misleading, as we have found in several instances where electric light has been substituted for gas the bills have been reduced. In our own knowledge this has been caused by great extravagance in the previous use of gas, both from bad burners and careless control, which, of course, is exactly the reverse with electric lighting. Electric light at 6d. per unit., burning against gas at 2s. 6d., is undoubtedly dearer burning hour by hour, but any additional cost is far more than compensated by the advantages gained from better control, increased cleanliness, &c."

And now we will quote instances which are the result of special enquiry made amongst consumers. Mr. Alderman Ellis, the able chairman of the Electric Lighting Committee at Portsmouth, was good enough to give us extracts from reports of consumers, and these, it may be mentioned, were obtained some months ago when electricity was new to Portsmouth, at which time there is always a tendency to waste current. Gas at Portsmouth, it must be remembered, costs 2s. 4d. per 1,000.

"A large brewery owner reports a considerable saving since its adoption in the brewery."

"Same owner has two houses and reports amount paid for electric light exactly same as gas."

"Grocer in very large way of business reports gas for quarter, March to June, 1894, £37 11s. 6d. 'for seven shops;' he now has five wired and lighted by us, and same quarter, 1895, combined bills, gas for two and electricity for five, amounted to £37 13s. 2d."

"A gunsmith reports bill for last quarter amounting to 4s. less than same quarter last year for gas."

"Furniture shop reports a slight saving in the year, although he heats glue pot and irons by electricity."

Mr. Ellis considers that to a very large extent these results are due to instilling into the minds of consumers the necessity of an ample number of switches.

It is a far cry from Portsmouth to Lancaster, but we will conclude this article with an interesting letter on the subject from Mr. H. Wilkinson, the proprietor of the Athenæum Theatre, Lancaster.

"From a comparative test made some time ago, I find that the lighting of my Theatre with the electric light, costs *considerably less* than what it did when the place was lighted with gas. The period of the test extended over 2 years for each, and gas here costs only 2s. 6d. per 1,000 feet. The saving to me is over £15 per year besides being so much cleaner and better to work on the stage. I may also say that I have two arc lamps (1,500 candles each) outside my Theatre, whereas I had no lights outside when I was using gas.—Yours truly, H. Wilkinson."

As will be observed from Mr. Wilkinson's letter, gas costs 2s. 6d. per 1,000. On the other hand electricity is fairly cheap, the price being 5d. per unit. One could not desire clearer testimony of the fact that under some circumstances electricity is actually cheaper than gas, and next week we hope to give some more interesting examples of the comparative cost of gas and electricity.

(*To be continued.*)

PROCEEDINGS OF SOCIETIES.

The Northern Society of Electrical Engineers.

On Cheap Steam Power. By J. S. Raworth, member. (Paper read November 10th, 1896.)

The main muscle of civilisation is the steam engine. Steam supplies the power and man directs it. The price at which steam power can be supplied is the principal factor in determining at any moment the degree of domination which man may exercise over the world in which he lives. These are facts which, when they may be in danger of being forgotten by the general public, will still shine brightly in that atmosphere which I trust may at some not distant day be called the fair firmament of Manchester. When that day comes, as it undoubtedly will, when the Mayor and Corporation having awoke to the knowledge that smoke and smuts no longer contaminate the air they breathe, and on the strength of that knowledge restore to the Town Hall the natural colour of its stone, you will enjoy the felicity of feeling that you, with your electricity, have been the main movers in that marvellous metamorphosis.

Considering the vital importance of this subject to the world generally, and to Great Britain in particular, it is somewhat strange that we have never been treated to a Royal Commission to inquire whether we engineers were really doing our level best to put this country in a position to obtain the highest possible return in power for the expenditure of its native treasures of coal and labour.

The difficulties of determining, in any particular case, the conditions of maximum efficiency have, however, been so great, owing principally to the preponderating influence of local circumstances and to the great difficulty of making accurate tests, especially with small engines, that one cannot imagine even a Royal Commission coming through such an enquiry with much *eclât*.

It may appear to the builders of large engines, such as are used in Manchester and Bolton, that the problem is not so seriously complicated after all, and it may be admitted that their section of the problem is fairly simple—the conditions being practically alike in all cases. But there are more small engines than large ones, and it is highly probable that in aggregate power the small engines far exceed the large ones. Large engines have had expended upon them much skill and ingenuity, and in consequence have attained a high degree of excellence; but small engines, until electricity came on the stage, were like gutter children, neither understood nor cared for, and yet they take more than their share of the coal bill of the country.

The cost of steam power is made up of several main elements, which may be stated as follows :—

(*a*) Coal per horse-power hour.
(*b*) Labour per annum.
(*c*) Maintenance { oil, stores, ordinary repairs, &c.
(*d*) Interest on capital.
(*e*) Depreciation (amortisation).
(*f*) Direct and consequential cost of break-down.

It is obvious that the last item (*f*) cannot be expressed in figures, but it is nevertheless a serious and important one, and the items (*d* and *e*) are often inflated in the hope of diminishing it. Water is not included, as it is commonly obtained free, or at a very small cost.

These five principal items of expenditure, although stated separately, are to some extent inter-dependent.

(*d* and *e*) Interest and depreciation being fixed charges on capital may be bracketed together at 10 per cent. on total prime cost of engines, boilers, land, and buildings.

(*a*) Coal usually grows less as (*d*) and (*e*) increase, but not in any well defined ratio.

(*c*) Maintenance, on the other hand, has a tendency to increase with refinement and elaboration in detail.

The relative importance of the several items depends entirely on the amount of power developed per annum—in short—on the load factor. The variations which occur in practice are so great that it must suffice to take two well-known cases.

1. Cotton mill engine working 2,700 hours per annum at 90 per cent. of full power.

2. Electric light engines working at full power 500 hours per annum.

The first instance gives us a load factor of

$$\frac{2,700}{8,760} \times \frac{90}{100} = 27{\cdot}7 \text{ per cent.}$$

The second gives us a load factor of

$$\frac{500}{8,760} = 5{\cdot}7 \text{ per cent.}$$

Both at first sight appear ridiculously small, but it is doubtful whether a much larger load factor than that of the cotton mill example is ever obtained, except in the isolated cases of some factories which work night and day, and occasionally with pumping engines. The figures for the two examples work out as below:—

EXAMPLE No. 1.—COTTON MILL.
1,000 H.P. CORLISS.

Total capital expenditure = £10,000.

(a)	Coal at 2 lbs. per 1 H.P. and 10s. per ton ...	£1,084
(b)	Labour	243
(c)	Maintenance	250
(d) (e)	10 per cent. on £10,000	1,000
		£2,577

= 0·254d. per H.P. hour,

of which the items are as below.

(a)	=	·105
(b)	=	·024
(c)	=	·025
(d) (e)	=	·100
		·254d.

Even in this case the capital charge is about equal to the coal and labour combined.

EXAMPLE No. 2.—ELECTRIC.
1,000-H.P. CORLISS.

Total capital expenditure on steam power only = £16,000.

The increased cost over example No. 1 is due to the subdivision of power and increase in size of buildings.

(a)	Coal at 4 lbs. per I.H.P. and 10s. a ton ...	£445
(b)	Labour	475
(c)	Maintenance	500
(d) (e)	10 per cent. on £16,000...	1,600
		£3,020

= 1·44d. per H.P. hour,

of which the component parts are as below.

(a)	=	·215
(b)	=	·225
(c)	=	·24
(d) (e)	=	·76
		1·44

The basis of the calculations are assumed to be as nearly alike as practicable—that is to say, the engine, boilers, buildings, and coal are taken to be similar in efficiency, style, and relative cost.

In the second example the horse-power hour costs six times the sum that it costs in a cotton mill, and the item of capital charge is multiplied by 7½. Moreover, the charge for capital exceeds all the other items by 13 per cent.

The most striking feature of these two examples is the item of coal; in a cotton mill it is the predominating factor of cost, but in an electric lighting station it only stands at 14·7 per cent. of the total charges.

At first sight, therefore, anyone might think that although economy in coal may be desirable in a cotton mill, it is of little importance in an electrical lighting station; but this is not so. Mr. Crompton, in one of his always excellent papers, read in April, 1894, before the Inst. of Electrical Engineers, said:—

"I agree with Prof. Kennedy that the importance of the cost of fuel used on electrical energy supply works is not to be measured merely by the money spent on the fuel itself, but that it is, to a certain extent, a measure of the quantity of plant that must be employed, and so affects the cost of up-keep of the plant, and to some extent every cost item except, perhaps, management and profit."

I am prepared to go a step further, and to say that it affects those items also. In other words, an increase in the coal bill means an increase in boilers, pumps, pipes, economisers, flues, and labour; the only item which is not increased is the cost of the engine itself, for no doubt can be entertained that a wasteful engine does not cost more than an economical one, it usually costs less.

We now come to the practical question—Can the cost of steam power be reduced? and if so—how?

The papers read before this Society during the last session, and the discussions thereon, demonstrated most clearly that your members have a firm grasp of the subject, and consequently that it would be sheer waste of time to bring this most important question before the Society without attempting to provide an answer which may at least enable you to realise in some practical and tangible form the aspiration of all engineers and manufacturers after cheap steam power.

This is the object of the paper. The two examples given above are intended to be as nearly as possible typical of two power plants working with similar engines under widely dissimilar conditions. We now proceed to inquire what improvements are possible, and how those improvements can be affected.

Considering the fact that at present the capital charges amount to about one-half of the total cost of steam power, it is obvious that economy in coal obtained by means of increased capital outlay is not likely to have much beneficial effect.

That this factor in the equation is fully understood in Lancashire is shown by the statement of Messrs. Hick Hargreaves & Co., whose opinions naturally and very properly carry great weight.

"That in the majority of cases the saving of fuel to be gained by the use of even triple expansion engines would not balance the accompanying disadvantages, such as extra first cost, greater complication, and consequent risk of breakdowns."

With this opinion before us, which is in absolute conformity with the teaching of the two examples quoted, it may be assumed that the improvement aimed at must be gained by a diminution either of all the items of cost, or at least of some without increase of the others.

It may also be observed that, with regard to our indefinable item (*f*), Messrs. Hick Hargreaves & Co. consider that the risk of breakdown increases with complication.

At this point it is necessary to consider exactly how much power can be obtained from a given quantity of steam; we might even go further and say, "from a given quantity of coal," but that would open up a field far too wide for one evening's work.

Record figures are useful as a basis of comparison, and although they may not ordinarily be realised in practice, they stimulate mental activity, and tend to improve results all round.

Whenever an existing record is surpassed, we may conclude that the engine tested possesses all the good points of its predecessors, and at least one special one of its own, and if we can succeed in defining the exact nature of that special improvement, then we may conclude that engineering science has advanced at least one step.

The standards of steam consumption per I.H.P., as they are generally understood to-day, are as below, subject, of course, to those corrections which the varied and highly critical knowledge of the subject possessed by members of the Society will naturally suggest:—

		Condensing.	Non-condensing.
(a)	Vertical compound, moderate speed	18·5 ...	24·5
(b)	Ditto, high speed	17·0 ...	22·0
(c)	Vertical Corliss, slow speed ...	15·5 ...	21·0
(d)	Horizontal Corliss	14·5 ...	20·5
(e)	Triple Corliss	12·5 ...	...

The examples from which these figures have been taken are given in Appendix.

This list of five different types comprises the principal style of engines now in general use—it may be fairly stated of them that as they increase in economy they increase also in cost—the apparent economy is not all real, because speaking generally, and without regard to any particular case, the mechanical efficiency falls off as the thermal efficiency rises. Unfortunately, the exact efficiency of large engines is very difficult to determine, but from the available data, it may be taken that the best examples do not surpass 92 per cent., and the worst do not fall below 86 per cent.

The increase of cost with increase of economy is by no means regular, neither is it as great as might be expected, having regard to the engine alone; the Corliss engine is, for its size and weight, a cheap engine to build, and if the fly-wheel be left out of the calculation it is probably no more costly than its smaller and quicker competitors. In this it resembles man's first and fastest friend—my lady fair, who costs little and eats less but wears all she can get. Fly-wheels, foundations, and fancy framing, all very expensive, go to swell the cost of installing a Corliss engine.

It will be noticed that the Corliss engine, in its several forms, leads the list in economy of steam, and although several fitful attempts have been made by its rivals to equal its performance, they do not succeed in carrying off the palm of its well earned popularity.

The Corliss engine in this country dates from the year 1863; and half a page of its history is necessary to show why it came, and why it stayed. Prior to its advent, mill engines, and indeed all engines, so far as they were governed at all, were governed by the Watt governor and throttle valve, which gives but poor results mechanically, and with single expansion engines is a particularly wasteful arrangement.

There did not exist at that date a single form of automatic expansion gear suitable for large engines; the mill owner had therefore no option but to adopt throttle governing, which was both bad and wasteful—so when the Corliss engine arrived, with its excellent facilities for perfect governing and automatic expansion, it soon became first favourite—it had absolutely no rival worthy of consideration. Increasing boiler pressure only tended to emphasise the peculiar advantages of its admirable valve gear.

It is very curious to note that, while the real virtues of the Corliss engine are little spoken of, there is no end of admiration foolishly wasted on the peculiarly regular and square-cornered diagrams which it produces—but facts have dispelled this illusion—engines with no diagrams at all, so to speak, have run it very close, and even the common throttle valve beats it at low loads. Under these circumstances one must look further and deeper for the cause of its exceptional economy.

These causes, I believe, may be summed up under the two heads of *small clearance* and *good drainage*.

The loss from clearance is a very serious one to engines fitted with piston valves, especially when the stroke is short; the clearance may easily be as much as 15 per cent. of the volume swept by the piston.

Happily the pure clearance loss is definite, and may easily be cal-

culated, but there is an indefinite loss connected with it which cannot be so readily summed up; that is, the initial condensation due to increase of exposed surface, of the worst kind, moreover, for it is swept alternately by the live and exhaust steam.

The Corliss valve reduces the clearance very considerably, so much so, that it is possible in long-stroke engines to reduce clearance to about 3 per cent.

In the matter of drainage the Corliss engine also maintains its superiority.

A vertical engine with piston or slide valves has no natural drainage, and if it were run very slowly would fill up with water, and under any conditions of speed there must always be some water present. Any water carried up by the piston on the upstroke will be delivered into the exhaust port and retained by compression until it is met by the high pressure steam, when it will be blown back into the cylinder.

This defect exists also, but to a smaller degree, in a vertical Corliss engine, and prevents it achieving the same degree of economy as the horizontal pattern, in which the exhaust valves at both ends of the cylinder are placed at the lowest points.

In these engines the exhaust valve has a considerable capacity, and any large volume of water coming over with the steam will be swept into it and discharged at the next stroke, instead of being blown back into the cylinder.

With all these advantages in favour of the horizontal Corliss engine, advantages which are costly in price of engine, buildings, and foundations, how can it be possible for any other type of engine to reduce the total cost of steam power?

In the first place, I should remark at electric lighting stations working under peculiar conditions, very uneconomical engines, if cheap and small, will probably be more economical on the whole than the highest class of Corliss engine, provided that one engine and dynamo of a size suited to the day load shall have the highest known efficiency, thermal and electrical. That particular set of plant may work 18 hours out of the 24, and will repay any reasonable expenditure of capital on its construction, but the full load plant works such a short time per diem, that economy in first cost, including boilers, becomes the first consideration.

These facts are so fully appreciated by members of this Society, that I should not have dared to trespass on their time by reciting them, but for the absolute necessity of making a paper of this kind logical and coherent.

To indulge in aspirations after better things may be evidence of a devout mind, but unless some way be made evident by which those better things may be attained, the result is not likely to be immediately beneficial to the human race.

The members of this Society are fully aware that an idea, which has quite lately appeared on the face of this globe for a novel method of constructing a steam engine, has selected one of your members as the medium of its incarnation, and as that idea has received the unqualified approval of many leading lights of the engineering profession, I need not apologise for taking this opportunity of endeavouring to show how that idea may be utilised to hasten the attainment of some of the objects described in this "paper."

The construction of the Universal engine is now so generally understood, that I need not occupy any time in describing it, more particularly as it is only one part, namely, the leading idea as embodied in its steam cycle and the means employed in effecting it, that has any particular bearing on our subject this evening.

The construction of the cylinders, pistons and valves, is applicable to all classes of engines, whether long stroke or short stroke, vertical or horizontal—the modification necessary for a horizontal engine being quite simple.

Comparing the arrangement of valves and cylinders with that of the Corliss engine, as being the acknowledged best existing, we find—

(*a*) The clearance can easily be made less for a given length of stroke.

(*b*) The surface exposed to initial steam pressure is also less.

(*c*) The drainage is obviously better in both cylinders, and in the receiver.

(*d*) The valves are entirely embedded in or between the cylinders, thus reducing loss by radiation.

These palpable facts all point to an increase of economy; how great it is difficult to say; the margin between the actual Corliss compound using 14½ lbs. of steam per I.H.P., and the theoretical engine working under similar conditions, is about 6 lbs., or 41½ per cent. There is therefore most obviously plenty of room for improvement.

As regards actual facts derived from careful tests of the Universal engine, there are at present only a limited number, but they have been taken from exceedingly small engines—the published figures were obtained from an engine having a 14½ inch L. P. cylinder by 6 inch stroke, the consumption at 45 H.P., with 140 lbs. boiler pressure, was 19·8 lbs. per I.H.P. after the trial—the H.P. clearance was found to be excessive, and the piston was lowered ⅜ inch, which reduced the consumption to 19·3. This diminution of clearance did not alter the area of exposed surfaces.

I believe, subject, of course, to correction, that this figure of 19·3 is a record figure for any size of engine, and it may certainly be expected to improve in larger engines and under more favourable conditions, for during the test we had 88 feet of steam pipe in circuit, of which 44 feet were uncovered.

The theoretical consumption for the conditions of the trial is 16½ lbs., leaving a margin of only 16 per cent. This, however, must not be directly and rigorously compared with the 41½ per cent. mentioned above, as it is well known that non-condensing engines can more easily get a higher percentage of their theoretical possibility than condensing engines.

(To be continued.)

Physical Society.

October 30th, 1896.

Captain Abney, President, in the Chair.

A letter was read from Lord Kelvin, thanking the Society for the address which the president, on their behalf, had recently presented to him.

Prof. W. Stroud read a paper by himself and Mr. J. B. Henderson on A Satisfactory Method of Measuring Electrolytic Conductivity by Means of Continuous Currents.

The method consists in placing a balancing electrolytic cell in the arm of the Wheatstone's bridge adjacent to the arm containing the chief electrolytic cell, so that the electromotive force of polarisation in the two cells neutralise each other's effect on the galvanometer. The authors find that if the resistance of the arms of the bridge are high (20,000 ohms), and if an E.M.F. of about 30 volts is used in the battery circuit, then the resistance of a solution (of potassium chlorate in their experiments) can be determined to within about one part in 2,000. With a D'Arsonval galvanometer, the balancing cell is so efficacious that it is impossible to tell that it is not a metallic resistance that is being measured.

Prof. Perry asked if the authors had tested whether the difference in resistance of the two cells was proportional to the difference in length of the liquid columns.

Mr. Appleyard said he had found that the resistance of an electrolyte appeared to vary, because in the ordinary arrangement the cell was short-circuited through the arms of the bridge. He suggested as a remedy the making and breaking of the circuit by a special key, so arranged that except when taking a reading the cell is on open circuit.

Mr. Blakesley asked if the authors had tried the method in which the resistances are adjusted till, when the battery circuit is broken, there is no immediate change in the galvanometer deflection. It is possible by this method to measure a resistance of between 6,000 and 10,000 ohms to within 0·1 per cent.

Prof. Ayrton said the method referred to by Mr. Blakesley was the ordinary "false zero" method. In using this method, you were working to a continuously altering zero. In Prof. Stroud's method, however, the zero was constant.

Mr. Appleyard said he had found the "false zero" method troublesome to use.

Prof. Stroud, in reply, said they had not tested the proportionality between the resistance and length, and they had not tried the "false zero" method.

Mr. Appleyard then exhibited a number of different forms of Electrical Trevelyan Rockers.

The most interesting one consisted of two rods of carbon fixed to a wooden sounding board, with a third carbon rod lying across the other two, so as to form a microphone. A fairly strong current is passed through this microphone and through two electro-magnets, which act on the prongs of a tuning fork fixed to the sounding board. The tuning fork acts on the microphone, which, by making and breaking the current, keeps the fork in vibration.

A cylinder of carbon, forming the "knife edge" of a small pendulum, supported on two horizontal carbon rods, kept the pendulum in violent oscillation as long as a current passed from one of the horizontal rods through the movable cylinder, and out through the other horizontal rod.

The Society then adjourned till November 13th.

SOME NOTES ON SUPERHEATING.

In addition to the valuable notes on engine breakdowns, which appear in the report of the Engine and Boiler Insurance Company, Mr. M. Longridge, chief engineer, has something to say on superheating. He states that from 1 to 5 per cent. of steam is condensed as a rule in the steam pipes and valve chest of an engine. The water can be removed by a separator. Mr. Longridge has considerable faith in the working of a simply designed water separator. To obviate 1 per cent. of condensation, about 19° of superheat are necessary. To prevent a 5 per cent. condensation requires 100° of added temperature. The recent growth of interest in superheating has shown many figures to uphold these views, and to convince that very little really superheated steam has yet been employed, and that the considerable benefits accruing have been due to the abolition of wetness. Mr. Longridge, however, refers to one case of actual superheat being employed. In one trial the superheat was 300° at the superheater, and 283° at the steam chest. At the end of the stroke the steam was dry, and though the pressure was only 168 lbs. in the boiler, the steam per H.P. hour was 10·17 lbs. only, the lowest yet recorded, or really 11·47 lbs. if the superheat be counted as its equivalent in saturated steam. Mr. Longridge, however, is of opinion that the saving would not be very great in this compound engine as compared with a triple engine, using the same pressure of saturated steam. He takes into his view the limit of 56½ working factory hours and cheap fuel, and thinks the advantages of so great a heat will not commend themselves to steam users working under these limitations. The difficulties of superheat increase so rapidly with high pressure that Mr. Longridge considers it to be impracticable—probably impossible to carry dry steam through all three cylinders by initial superheat. With a single cylinder engine it might be done at moderate pressures.

As Mr. Longridge mentions the McPhail and Simpson cycle in superheating, it may be suggested that in place of the pass through the boiler some at least of the superheated steam might be passed

through a coil in one or both the intermediate receivers with a view to seeing what benefit, if any, could be thereby secured. He considers that the gases heating a superheater should have a temperature at least 450° or 500° above that of the intended superheated steam. With such a difference the heat transmitted will be six thermal units per square foot of surface exposed to the gases per degree of difference of temperature. He does not mention the time in his report, but we conclude the hour is the time intended. If the temperature head be only 150 to 200°, the rate of transmission will be reduced sixfold. Hence the desirableness of putting superheaters in a hot part of the flues, or their surface must be abnormally large, and their effect little more than drying. Thus a special furnace might be employed to heat the superheater, and the gases therefrom could go to heat the boiler. In such a case, and without some such device as McPhail's reducer or the receiver coil we suggest above, special care is needed for regulating the superheat to prevent mischief, and Mr. Longridge recommends the power to use steam both *viâ* and outside the heater, and that such supply should be automatically regulated. This is Wethered's combined steam over again. He concludes by urging the necessity of dampers to stop the supply of heat to the superheater. This is not possible with the McPhail system, nor do we yet hear of any system in which this is done except where independent furnaces are employed to heat the superheater. Nor have we learned of any serious mischief having arisen from want of dampers in the McPhail system.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1896.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn*, *London*, *W.C.*, *to whom all inquiries should be addressed.*]

23,743. "Improvements in dynamo-electric machines." G. Cheffey-James and H. P. Ward. Dated October 26th.

23,778. "Improvements in electric indicators of water level." J. E. Hutton. Dated October 26th.

23,805. "Improvements in or in connection with incandescent electric lamps." F. A. M. Naumann (commonly known as A. Norman). Dated October 26th.

23,816. "Improvements in conduit tubes, more especially suitable for electrical conductors." E. H. Johnson. (E. T. Greenfield, United States.) Dated October 26th.

23,827. "Improvements in and connected with electrical storage batteries." E. W. Bonson. Dated October 27th.

23,868. "Insulating compound." L. Honig. Dated October 27th. (*Complete.*)

23,871. "Improvements in and relating to commutators and collectors for dynamo-electric generators and electromotors." C. H. Wade, J. Moores, and H. O. Farrell. Dated October 27th.

23,934. "A polar relay." T. B. Dixon. (Date applied for under Patents, &c., Act, 1883, Sec. 103, March 27th, 1896, being date of application in United States.) Dated October 27th. (*Complete.*)

23,942. "Improvements in or relating to electric switches or circuit breakers." R. Belfield. (A. J. Wurts, United States.) Dated October 27th.

23,980. "Improvements in electric stop motion drawing frames for fibrous materials." F. Arrowsmith. Dated October 28th.

23,992. "A new system of electrical propulsion for cycles and common road and other vehicles." R. A. Marples. Dated October 28th. (*Complete.*)

24,019. "Improvement relating to electric batteries." L. J. H. Rochate. (Date applied for under Patents, &c., Act, 1883, Sec. 103, April 21st, 1896, being date of application in France.) Dated October 28th.

24,062. "Improvements in or relating to brackets or holders suitable for electric lamps and the like." W. Sumner. Dated October 28th.

24,075. "Improvements in suspenders for electric lamps." T. Laurie. Dated October 29th.

24,084. "Improvements in or applicable to switches for electromotors and the like purposes." J. P. Hall and W. H. Seville Craven. Dated October 28th.

24,152. "Improvements in signalling apparatus for electric railways or tramways." H. H. Lake. (H. A. Parrish, United States.) Dated October 28th. (*Complete.*)

24,177. "Improvements in and relating to dynamo-electric generators." C. H. Wade, J. Moores, and H. O. Farrell. Dated October 30th.

24,178. "Improvements in and connected with magneto- and dynamo-electric machines." C. H. Wade, J. Moores, and H. O. Farrell. Dated October 30th.

24,190. "Improvements in electrolier ceiling fittings." H. D. Hinks. Dated October 30th.

24,220. "Electric lamp for cycles or other carriages and any other purpose." A. Riddell. Dated October 30th.

24,223. "Improvements in electric switches." I. H. Storey H. L. Storey, J. Parkinson. Dated October 30th.

24,235. "An improved electric lamp." D. Forbes. Dated October 30th.

24,291. "Improvements in electric burglar alarms." W. H. Ward. Dated October 30th.

24,329. "Process of and apparatus for mechanically inserting filling material into electrodes." F. Wuste. Dated October 30th.

23,348. "Improvements in fittings for electric and other lighting." C. E. Bulling. Dated October 30th.

24,350. "Improvements in reflectors for electric lamps." R. Jones. Dated October 30th.

24,351. "Improvements in or relating to electric railways." A. H. Brunn, V. Takacs, L. de Reymond-Schiller, and P. Westphal. Dated October 30th. (*Complete.*)

24,367. "Improvements in conduits for electrical conductors." E. Lavens. Dated October 30th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price*, *post free*, 8½*d.* (*in stamps*).]

1895.

8,904. "Improvements in primary and secondary galvanic batteries." C. L. R. E. Menges. Dated May 4th, 1895. *Primary and secondary batteries.*—This invention relates to primary and secondary battery plates of the kind described in Specification No. 11,923, of 1887, and to moulds for producing the same. It consists, firstly, in filling the grids, which have upwardly inclined receptacles, with blocks of active material rendered solid by moulding or pressing, and said material may also be rendered more cohesive by the admixture therewith of fine lead wire, asbestos, hair, or adhesive substances such as shellac or caoutchouc. The drawings show modifications of casting moulds for such plates wherein the lines of division between the two parts of the mould are irregular or zigzag in form, and these lines may also be of a wavy or undulating shape. 5 claims.

10,302. "Improvements in connection with laying submarine electric cables." C. S. Snell. Dated May 24th, 1895. The cable to be laid is carried on a drum in a tank having an overhead guide rack which supports a travelling pulley. The travelling pulley is in a pivoted frame and acts by means of an eccentric or a double escapement attached through bevel gear to a worm engaging with the rack, thus causing the pulley to traverse as the cable is unwound. The cable thence passes over a pulley to two pulleys, one of which is connected to the hydraulic plunger so that any slack can be taken up or any extra strain can be relieved. The cable is finally paid off from a driven stern pulley. The apparatus is described as driven by hydraulic engines controlled by automatically actuated valves as well as a hand-valve. Pulleys for light cables are constructed with double pneumatic tyres, the cable rising on the solid rubber junction piece between the tyres. 4 claims.

10,359. "Improvements in carriers for shades and the like objects for gas and electric light fittings and the like." E. W. Lancaster. Dated May 27th, 1895. Relates to electric lamp globe holders and consists of pivoted arms for holding the globe, having their inner ends entered in eccentric slots of a ring so that by turning the ring the arms open or close on the globe. 1 claim.

10,360. "Improvements in tumbler switches for electric circuits." E. W. Lancaster. Dated May 27th, 1895. Relates to tumbler electric switches and consists of a plate or block carrying a movable contact pivoted to the handle and also to a bar pivoted at the fixed terminal, and fitted with a spring to give a quick break. On moving the handle the contact carried on the plate is forced down between fixed contacts to complete the circuit. 2 claims.

11,233. "Improvements in arc lamps with hand regulation." J. Peschek. Dated June 7th, 1895. Relates to a lamp which can be used in an inclined position for continuous currents, or in a vertical position for alternating currents. The carbon holders are attached to guides, movable between bearings carried by the frame, and actuated to strike and regulate the arc by means of a pinion or worm wheel gearing with racks on the guides, and with a screw, &c., attached to a rod with a milled head. In a form shown the lower carbon is held by a ball pressed against the carbon by a spring. The upper carbon is secured by a spring or equivalent device, a sleeve being inserted for use with a smaller carbon when alternating currents are used; the circuit is completed through the upper carbon holder by means of sliding contacts. The lamp frame is adjustably carried by a standard to permit of the fixing of the lamp in any required position. 7 claims.

1896.

17,643. "A pocket electric lamp for use by surgeons and the like." R. A. Smith and F. G. Bowley. Dated August 10th, 1896. Relates to a pocket electric lamp, and consists of a battery of dry cells contained within a case for the pocket. From the terminals of the battery the line wires are led to a small incandescent lamp which projects from a flexible tube placed in circuit, which is made and broken by means of a press button. The flexible tube facilitates the lamp being placed in the position required by the operator. The lamp is mounted upon the outer end by means of a small vulcanite stem filled with plaster of Paris, serving as a holder and reflector for the lamp. 1 claim.